PB85-169019

Mountain Communities Wastewater Management Alternatives Report. Volume 2 Technical Engineering Alternatives

(U.S.) Environmental Protection Agency
Atlanta, GA

Nov 84

U.S. Department of Commerce
National Technical Information Service
NTIS

BIBLIOGRAPHIC INFORMATION

PB85-169019

Mountain Communities Wastewater Management Alternatives Report. Volume 2. Technical Engineering Alternatives.

Nov 84

PERFORMER: Environmental Protection Agency, Atlanta, GA.
Region IV.
EPA/904/10-84/125

See also PB85-169001, and PB85-169027. Also available in set of 4 reports PC E99, PB85-168995.

This volume contains Chapter 3--Technical Engineering Alternatives. Chapter Three describes applicable technical approaches to wastewater management in small mountainous communities by system type (on-site, cluster, small community and centralized). Tabular summaries--fact sheets--of each system are also included.

KEYWORDS: *Environmental impacts, *Waste water, *Water quality management.

Available from the National Technical Information Service, SPRINGFIELD, VA. 22161

PRICE CODE: PC A08/MF A01

PB85-169019

United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, GA 30365

EPA 904/10-84 125
November 1984

EPA

Environmental Assessment

Mountain Communities Wastewater Management Alternatives Report

Volume II - Technical Engineering Alternatives

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV - ATLANTA

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES REPORT
VOLUME II

NOVEMBER 1984

VOLUME II

TABLE OF CONTENTS

		Page
LIST OF TABLES		i
LIST OF FIGURES		ii
	INTRODUCTION	iv
Chapter 3	TECHNICAL ENGINEERING ALTERNATIVES	3-1
	3.1 Introduction	3-1
	3.2 Wastewater Engineering Technique	3-3
	3.2.1 Wastewater Treatment Containment and Disposal for Individual Establishments	3-3
	3.2.2 Cluster Systems	3-9
	3.3 Installation/Construction Techniques	3-20
	3.4 Operation, Maintenance and Repair	3-25
	3.5 Enhancement Techniques for Small Wastewater Systems	3-36
	3.6 Preferred Design Practices	3-39
	3.7 Evaluation of Alternative Engineering Techniques	3-43

FACT SHEETS

BIBLIOGRAPHY

APPENDICES

II-A Site Soil Survey Procedures

II-B State Health Department Contacts

VOLUME II

LIST OF TABLES

No.	Title	Page
3-1	Wastewater Engineering Techniques for Individual Systems in Mountainous Areas	3-5
3-2	Limiting Characteristics of Wastewater Disposal Techniques for Individual Establishments and Cluster Systems	3-6
3-3	Relationship Between Wastewater Application Rates and Residential On-Site Wastewater Disposal Space Requirements	3-10
3-4	Wastewater Engineering Techniques for Cluster Systems in Mountainous Areas	3-11
3-5	Design Features of Land Application Techniques for Cluster and Small Community Systems	3-14
3-6	Wastewater Engineering Techniques for Small Community Systems in Mountainous Areas	3-16
3-7	Wastewater Engineering Techniques for Centralized Systems in Mountainous Areas	3-17
3-8	Limiting Characteristics of Wastewater Collection Technique	3-18
3-9	Methods for Avoiding Common Problems for Installing Small Wastewater Systems	3-21
3-10	Operation, Maintenance and Repair of Small Wastewater Systems	3-26
3-11	Estimated Septic Tank Pumping Frequencies (In Years) for Year-Round Residences	3-34
3-12	Operation, Maintenance and Repair (OMR) Activities for Cluster, Small Community and Centralized Wastewater Techniques	3-37
3-13	Constraints Which May Affect the Selection of Appropriate Engineering Techniques	3-46
3-14	Various Site Constraints Which Will Affect Selection of Disposal Techniques	3-47
3-15	Costing Considerations	3-48
3-16	Environmental Factors That are Important in the Selection Process	3-49
3-17	Operation Considerations for Alternative Wastewater Engineering Systems for Rural Areas	3-50
3-18	Implementation Considerations for All Types of Wastewater Systems	3-51

3<

VOLUME II

LIST OF FIGURES

No.	Title	Following Page
3-1	Fact Sheet -- Septic Tank	3-54
3-2	Fact Sheet -- Aerobic Treatment	3-54
3-3	Fact Sheet -- Sand Filtration	3-54
3-4	Fact Sheet -- Disinfection	3-54
3-5	Fact Sheet -- Holding Tank	3-54
3-6	Fact Sheet -- Privy	3-54
3-7	Fact Sheet -- Siphon	3-54
3-8	Fact Sheet -- Pumping Tank	3-54
3-9	Fact Sheet -- Soil Absorption Trenches	3-54
3-10	Fact Sheet -- Soil Absorption Seepage Bed	3-54
3-11	Fact Sheet -- Soil Absorption Mound	3-54
3-12	Fact Sheet -- Soil Absorption Trenches Operated in Parallel	3-54
3-13	Fact Sheet -- Soil Absorption, Distribution of Effluent With Drop Boxes	3-54
3-14	Fact Sheet -- Soil Absorption, Subsurface Sand Filter Without Under Drains	3-54
3-15	Fact Sheet -- Soil Absorption, Filled/Built-Up Area	3-54
3-16	Fact Sheet -- Soil Absorption, Low-Pressure Pipe	3-54
3-17	Fact Sheet -- Soil Absorption, Shallow Trench(es)	3-54
3-18	Fact Sheet -- Soil Absorption, Alternating Trench System With Diversion Valve	3-54
3-19	Fact Sheet -- Septic Tank-Sand Filtration-Irrigation	3-54
3-20	Fact Sheet -- Evapotranspiration Bed	3-54
3-21	Minimum Isolation Distances	3-6
3-22	Fact Sheet -- Small-Diameter Gravity Sewers	3-54
3-23	Fact Sheet -- Septic Tank Effluent Pump, Pressure System	3-54
3-24	Fact Sheet -- Grinder Pumps	3-54
3-25	Fact Sheet -- Lagoon	3-54
3-26	Fact Sheet -- Marsh-Pond-Meadow	3-54
3-27	Fact Sheet -- Irrigation	3-54

4<

VOLUME II

LIST OF FIGURES (cont'd)

No.	Title	Following Page
3-28	Fact Sheet -- Conventional Gravity Sewers	3-54
3-29	Fact Sheet -- Vacuum Sewers	3-54
3-30	Fact Sheet -- Preliminary Treatment	3-54
3-31	Fact Sheet -- Rotating Biological Contactor (RBC)	3-54
3-32	Fact Sheet -- Trickling Filter	3-54
3-33	Fact Sheet -- Contact Stabilization	3-54
3-34	Fact Sheet -- Extended Aeration/Activated Sludge	3-54
3-35	Fact Sheet -- Advanced Treatment	3-54
3-36	Fact Sheet -- Sludge Treatment	3-54
3-37	Fact Sheet -- Septage or Sludge Disposal	3-54
3-38	Installation of Lateral Cleanout	3-34
3-39	Fact Sheet -- Waste Flow Reduction, Water Conservation	3-54
3-40	Fact Sheet -- Waste Flow Reduction, Wastewater Recycle/Reuse	3-54
3-41	Curtain Drain	3-39
3-42	Recommended Methodology for Selecting Preferred Engineering Techniques for New Systems	3-43
3-43	Recommended Methodology for Selecting Preferred System Rehabilitation Techniques	3-52

(Fact Sheets are located at back of Chapter 3)

5<

VOLUME II

INTRODUCTION

This is the second of four volumes which make up the *Final Alternatives Development Report* for the Mountain Communities Wastewater Management Assessment. This volume contains Chapter 3--Technical Engineering Alternatives.

Chapter Three describes applicable technical approaches to wastewater management in small mountainous communities by system type (on-site, cluster, small community and centralized). Tabular summaries--fact sheets--of each system are also included. Finally, a method is presented for selecting the most appropriate technique under given circumstances.

6<

CHAPTER 3

TECHNICAL ENGINEERING ALTERNATIVES

3.1 Introduction

The 82-county study area, called the highlands portion of southeastern Appalachia, has both environmental limitations and a past record of less-than-average funding available for wastewater management systems. The environmental limitations include steep slopes, shallow soils and shallow depths to groundwater. Less-than-average funding has resulted in a corresponding lack of proper design, installation and maintenance of many wastewater systems throughout the study area. Some of the problems include excessive amounts of water entering the wastewater system, improper locations in relation to soil characteristics, locations of water supply springs and wells, wastewater systems not large enough to handle maximum flows, systems that do not provide proper wastewater treatment or disposal, and lack of periodic maintenance and repair.

This chapter presents a wide assortment of alternative wastewater techniques which can be used for properly managing wastewater in rural mountain communities, households and businesses. The techniques presented include both designs for various types of wastewater systems and methods for repairing or maintaining existing systems. Both the techniques and the methodologies can be relevant for low-income rural residents, families with second homes, and residents in dense clusters of homes such as small communities, recreational areas or mobile home parks. Certain techniques and methodologies may be more relevant to one type of resident or homeowner than another.

Chapter three is organized into seven sections based on the different activities involved in wastewater engineering--planning, design, installation and operation/maintenance/repair. Section 3.2 provides a summary description of alternative designs for wastewater facilities suitable for individual homesites, cluster and small community systems, and larger scale collection and treatment systems. The techniques suitable for each of these settings are summarized on tables. Each technique is then described in greater detail on a fold-out fact sheet which summarizes specific uses, provides examples of uses within Region IV, contact persons and manufacturers. Finally, tables are presented which summarize the natural features which may limit the application of several general techniques.

Sections 3.3 and 3.4 discuss installation and construction, and operation, maintenance and repair issues associated with each alternative. Sections 3.5 and 3.6 discuss additional factors which will affect system performance including methods of enhancing performance of existing systems and practices which, if followed, could ensure better system design.

The final section of the Chapter, 3.7, sets forth a recommended procedure which local communities can use to identify the technical alternative or alternatives which are most appropriate for their needs and community conditions.

Cost information for each of the technical alternatives presented in this chapter is not given in any detail. Specific costs will be developed in detail in the final report.

8<

3.2 Wastewater Engineering Techniques

Numerous wastewater engineering techniques exist that are technically sound, efficient and easily adaptable to the complex topography and scattered population centers in southeastern Appalachia. Physical constraints pose problems for planning, design and installation of both large and small systems. Shallow depths to rock and groundwater hamper installation of system components (e.g. septic tanks and sewer conveyance systems). Installation of facilities can become costly because of rock excavation, and groundwater infiltration can lead to hydraulic overloading of both large and small facilities. All wastewater engineering facilities must be well planned and adapted to local environmental site conditions in order to be effective. Improper siting can lead to poor performance and high costs. Therefore, before considering the implementation of any sewage facility components, an evaluation should be conducted to assess landscape position, topography, drainage, geology and soil characteristics. Siting septic tank-soil absorption systems must also consider separation distances from wells and springs and other features which affect system performance.

3.2.1 Wastewater Treatment, Containment and Disposal For Individual Establishments

Wastewater engineering techniques utilized at individual homes and business establishments usually include a septic tank in conjunction with one of an array of soil absorption options for providing final treatment and disposal. Table 3-1 lists the many techniques available. Basically, soil absorption techniques consist of beds, trenches and mounds all of which can be constructed in various configurations to adjust to specific physical and site conditions. Where soils are deep and well-drained, trenches are preferred over beds due to the increased side wall area in trench configurations. Mounds extend the use of soil absorption particularly within areas where shallow soils of only two to three feet in depth are available. Mound systems allow the wastewater to be distributed over a more permeable topsoil layer thereby allowing the wastewater to be accepted and treated before reaching restrictive features such as fractured rock groundwater or a slowly permeable subsoil layer. Figures 3-1 through 3-20 present detailed descriptions of these different techniques which may be appropriate for individual establishments. More than one technique can be suitable for a particular site. Most types of equipment are commonly available. Names of specific manufacturers have been extracted from Public Works Journal Corporation, 1984; any listing of manufacturers does not indicate U. S. EPA endorsement. A list of both state health department and state environmental agency personnel, which are referred to in this chapter, appear in Appendix I-B.

Beds, trenches and mounds all have siting limitations related to land slope, hydraulic conductivity of the underlying soil, and depth of unsaturated soil below the disposal pipe. These are summarized on Table 3-2. Many limitations can be overcome with mounds, shallow placement or other variations of conventional on-site systems. Minimum distances separating wastewater units from other types of facilities are shown in Figure 3-21. Minimum design recommendations for on-site techniques have been published (U.S. EPA, 1980a; Salvato, 1982 and state guidelines).

Sizes of disposal areas shown in Table 3-2 are based on wastewater disposal rates of approximately three inches per week for beds, trenches and mounds and 12 to 14 inches per week for other types of on-site disposal. Such rates are much slower than soil hydraulic conductivity primarily in order to retain the capacity of soil to treat wastewater as it percolates downward to the water table and bedrock. Clearly, seepage pits and leaching chambers are not as preferred as beds, trenches or mounds in locations with limited unsaturated soil depth. Elevated mounds can be utilized with as little as two feet of unsaturated soil depth below the filter material. In areas with less than two feet of suitable, unsaturated soil, use of an on-site disposal system should be avoided in nearly all circumstances.

Various types of modifications to individual disposal systems are available. For example, a pump or siphon can be utilized to distribute wastewater evenly throughout a trench, bed or mound. These modifications

TABLE 3-1

WASTEWATER ENGINEERING TECHNIQUES FOR INDIVIDUAL SYSTEMS IN MOUNTAINOUS AREAS

TREATMENT	CONTAINMENT AND TRANSPORT	DISPOSAL
Septic Tank or Aerobic Unit	Privy Holding Tank	Soil Absorption[1] • Trenches (or pits) • Bed • Mound Evapotranspiration
Septic Tank and Sand Filter	Siphon Pumping Tank	Soil Absorption (see above) Irrigation[2] • open land • forest land Surface waters[2] Evapotranspiration Lagoon/Pond

---

[1] Other soil absorption techniques are available that are variations of the basic absorption techniques (see Figures 3-11 through 3-17).

[2] Disinfection is required prior to disposal.

11<

TABLE 3-2

LIMITING CHARACTERISTICS OF WASTEWATER DISPOSAL TECHNIQUES FOR INDIVIDUAL ESTABLISHMENTS AND CLUSTER SYSTEMS

	Typical Size of Disposal Area [1] (sq.feet of soil contact area per bedroom)	Maximum Land Slope[2] (percent)	Minimum/Maximum Soil Hydraulic Conductivity[3] (inches per hour)	Minimum Recommended Depths of Unsaturated Soil Below Pipes (feet)	
				To Water Table	To Bedrock
Soil absorption beds (fields) and trenches	400	25 for trenches 5 for beds	0.2/6.0	2-4	2-4
Seepage pits[4]	85	5	1.0/6.0	15	15
Leaching chambers[4]	85	5	1.0/6.0	15	15
Mounds	400	15	0.2/0.5	2	2
Eavpotranspiration beds	70	5	0.02/0.2	1	1

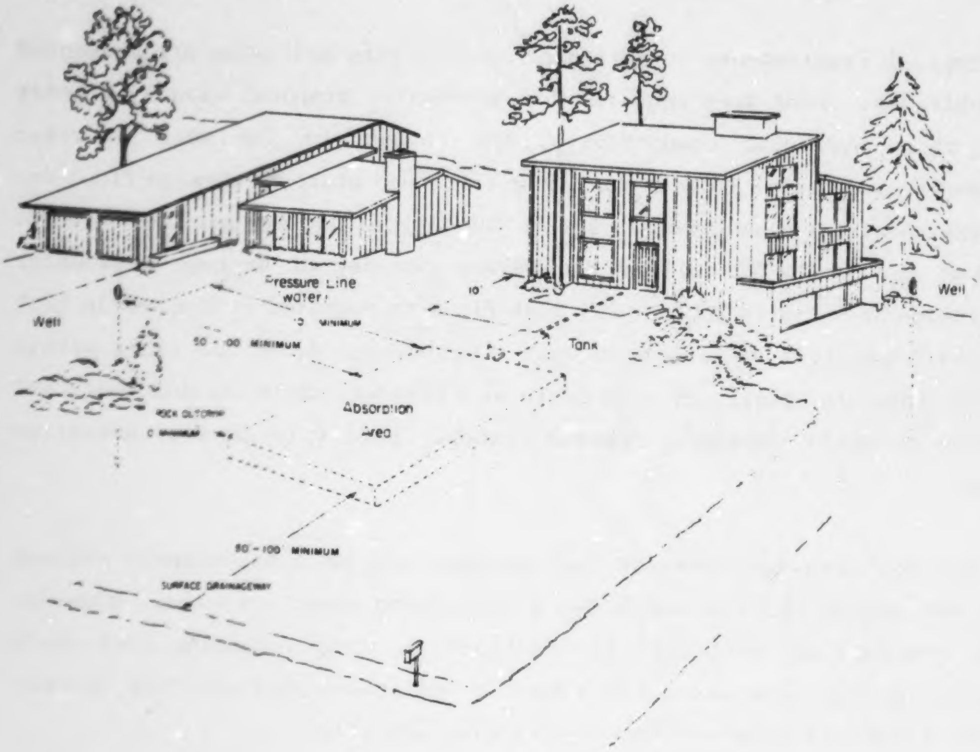
[1] Based on soil hydraulic conductivity, resting of soil to enhance treatment, and 100 gallons of wastewater generated per day per bedroom.

[2] Steep slopes pose problems with operating installation equipment. Special equipment or the use of hand tools may allow installation on steeper slopes.

[3] Based on results from percolation tests conducted at the disposal site.

[4] Not shown on Fact Sheets; these techniques are variations of more conventional soil absorption techniques.

Sources: U.S. EPA, 1980 and Pennsylvania DER, 1983.


Pressure Line (water)
Well
10'
10' MINIMUM
50 - 100 MINIMUM
Tank
Well
ROCK OUTCROP
10' MINIMUM
Absorption Area
50 - 100 MINIMUM
SURFACE DRAINAGEWAY

PREFERRED MINIMUM HORIZONTAL DISTANCES FROM SEPTIC TANK OR ABSORPTION AREA TO:

WATER SUPPLY WELLS	50-100 FEET
BUILDING FOUNDATIONS	10 - 20 FEET
PRESSURE WATER LINES	10 - 20 FEET
DRIVE WAYS	5 - 10 FEET
POOLS	10 - 20 FEET
ADJACENT ON-LOT SYSTEMS	10 - 20 FEET
STREAMS AND LAKES	50-100 FEET

SOURCE: PA. DER, 1983

MINIMUM ISOLATION DISTANCES

FIGURE 3-21

each present various possibilities for enhancing system performance as discussed in Section 3.6.

Typical requirements for sizes of on-site disposal areas are presented in Table 3-3. Land area required for wastewater disposal usually depends upon soil, hydraulic conductivity, the ability of the soil to treat wastewater and depths to both the water table and bedrock. Design flows for on-site facilities are commonly 300 to 400 gallons per day per household to account for 60 to 75 gallons per person per day of average wastewater generation and also to account for peak flows to a system with a septic tank or some other type of treatment unit. Wastewater detention times within septic tanks are usually 24 to 36 hours at a minimum, while aerobic units for on-site or small community systems commonly have 8 to 10 hour detention times.

Surface area requirements for trenches can be significantly reduced from the values shown in Table 3-3 by utilizing wider trenches. However, wide trenches are difficult to construct on steeply-sloping lots while maintaining the recommended 2 to 4 feet of vertical separation from groundwater, fractured rock or other restrictive features.

It is important here to discuss the impact non-residential wastes can have on the standard septic tank. Wastewater effluents from commercial/ industrial activities vary significantly from residential wastes. The biodegradeability of these wastes can differ due to different fractions of settleable, floatable and dissolved solids, thereby changing the efficiency of the standard septic tank. Standard septic tank designs are often inappropriate for treating non-residential wastewaters. In the case of restaurant wastes, designers must consider the high grease loadings to the treatment unit. Laundromats may require special prefilters in the treatment process to ward off potential soil clogging due to high BOD_5 levels, phosphate precipitates and lint. Lastly, schools without showers may be producing high concentrations of pollutants necessitating additional treatment from non-standard design septic tanks or aerobic units.

Given the physical problems in portions of the study area, many of the selected wastewater management techniques will consist of using some type of primary treatment followed by a soil absorption system for final treatment and disposal. For many parts of the study area, use of the septic tank-soil absorption system will be the preferred disposal/treatment alternative, simply due to its proven performance and lowest cost of installation and operation. Many people have not considered the septic tank-soil absorption system to be an effective, long-term solution to their wastewater problems. In fact, however, a properly sited, designed, installed and maintained septic tank-soil absorption system will effectively renovate wastewater and continue to function properly for twenty (20) years or more. Research conducted by E.J. Tyler, et al, 1977, concluded that the soil, in addition to the septic tank itself, is indeed capable of removing a very high percentage of the organisms and substances which are potentially harmful to human health and the environment, making this type system an environmentally sound alternative when properly sited, designed, installed and maintained.

3.2.2 Cluster Systems

The term "cluster systems" is used to denote a single wastewater system that collects, treats and disposes wastewater from a group of congregated establishments. Cluster systems can be more feasible from a public health and environmental standpoint than individual systems if, 1) establishments are too densely congregated for individual systems (less than one-third to one-half of an acre per establishment), 2) if variable soil conditions allow a large absorption area for a cluster to be more technologically feasible than absorption areas at each establishment, or, 3) if use of any absorption area is not possible and wastewater needs to be discharged to a surface water body. When considering soil absorption, this cluster approach often requires a considerable amount of land area for construction of both an absorption area and a reserve area for a potential replacement system. Table 3-4 describes various approaches which may be appropriate for cluster systems. Fact sheets included as Figures 3-22 through 3-27 provide more detailed information on techniques for cluster systems. In addition to techniques included on these fact sheets, many of the alternatives addressed under the section on individual systems may also be appropriate.

Linking individual establishments into one wastewater system requires a collection system that is designed to handle small flows and is suitable in the rough, hilly terrain found in mountainous areas. Depending on landscape features, gravity flow can be utilized to allow septic tanks to be connected by gravity to a package treatment facility. Pressure sewers can also be utilized for wastewater conveyance. Pressure sewers transmit pumped wastewater thereby allowing greater flexibility in mountainous terrain, because they can be utilized regardless of land topography. In addition, pressure sewers, by their design, prevent infiltration of rainwater and groundwater allowing for the use of smaller and cheaper small diameter pipe. Although construction of these sewers is less expensive than conventional gravity sewers, use and maintenance of pumps and controls may potentially offset any savings.

TABLE 3-3

RELATIONSHIP BETWEEN WASTEWATER APPLICATION RATES AND RESIDENTIAL ON-SITE WASTEWATER DISPOSAL SPACE REQUIREMENTS

Wastewater Application Rate gallons per day per square foot	Minimum Absorption Area Requirement square foot	Mounds		Seepage Beds or Fields		Trenches	
		Minimum surface Area, sq. ft.	Typical Dimensions ft. by ft.	Minimum Total Surface Area	Typical Dimensions ft. by ft.	Minimum Total Surface Area sq. ft.	Typical Dimensions ft. by ft.
0.05	6,000	6,000	(120'x50') (200'x30')	6,000	100'x60' or 2@100'x30'	25,000	114'x 100'
0.20	1,500	1,500	(15'x100')	1,500	15'x100' 30'x50'	5,800	58'x 100'
0.50	600	600	(10'x60')	600	10'x60' 20'x30'	1,800	18'x 100'
1.20	250	250	(10'x25')	250	10'x25'	750	15'x 50'

Assumptions

- Design flow of 300 gallons per day per household.
- Trenches--2 feet wide--Maximum length 100 feet and spacing between laterals of 6 feet.
- Dual Beds or Fields--20 foot separation distance. Surface and subsurface soil horizons have the same hydraulic conductivity.

TABLE 3- 4

WASTEWATER ENGINEERING TECHNIQUES FOR CLUSTER SYSTEMS IN MOUNTAINOUS AREAS

COLLECTION	TREATMENT	DISPOSAL
Small Diameter Sewers • Gravity • Pressure (with either effluent pumps or grinder pumps)	Septic Tank Aerobic Unit	Soil Absorption at one site[1] • Trenches (or pits) • Bed(s) • Mound(s)
Holding Tanks		Evapotranspiration
	Septic Tank and Sand Filter[2]	
	Lagoon	Irrigation[3] • open lands • forest land
	Marsh-pond-meadow (artificial or natural)	
		Surface Waters[3]

[1] Other soil absorption techniques are available that are variations of the basic absorption techniques (see Figures 3-11 through 3-17).

[2] The filter can provide for effluent to be recirculated.

[3] Disinfection is required prior to disposal.

A third conceivable option for wastewater collection is the use of vacuum sewers. A vacuum pump at a pumping station provides the vacuum source with valves located at each establishment. At selected intervals, sewer pipes must rise sharply to form a pocket where wastewater can collect. Air forces wastewater to the next section of downward sloping pipe. The advantages of reduced infiltration, reduced inflow and lower installation costs when compared to gravity sewers are the same advantages as are available for pressure sewers. Energy is required and equipment maintenance may be hindered by limited availability of parts. Vacuum sewers also have not been tested and utilized in more than a few innovative sewer systems.

Wastewater treatment techniques for cluster systems, in addition to the possible use of septic tanks at individual establishments, include use of one treatment facility designed and constructed as one system rather than as individual treatment units. If wastewater is to be discharged to a surface water body or above-ground to a land disposal site, secondary wastewater treatment, e.g. a lagoon or a biological treatment facility, is required by Federal regulations. Extended aeration is the most commonly utilized biological treatment unit for cluster treatment facilities.

Wastewater disposal options include use of soil absorption trenches, beds or mounds or discharge above-ground to an available land area or to a local water body. Table 3-5 presents design features which may limit the use of different land disposal techniques. Limiting factors for other disposal techniques were presented on Table 3-2. Any sludge from the treatment facility must also be managed. Costs and state permitting requirements (based on public health and environmental constraints) are the primary factors in selecting the most suitable disposal option.

3.2.3 Small Community Systems

The term "small community systems" is utilized in this assessment to denote wastewater collection, treatment and disposal facilities that handle flows from more than a handful of establishments but less than 100,000 gallons per day. Techniques for small communities include many of the cluster system techniques already described. Small community techniques are applicable when individual, cluster-type systems cannot adequately handle the wastewater management needs of the service area. Where sewage volumes and service areas are typically large, utilization of these techniques will require more in-depth planning and an analysis of alternatives to reach a cost-effective solution. In some instances the recommended plan may include several individual systems, several cluster or grouped facilities and possibly a large treatment unit that will service the needs of the more densely populated section of a small community.

Table 3-6 lists various techniques most often associated with managing waste flows from small communities. Wastewater disposal via underground soil absorption is usually too costly for all but the smallest community systems. For the larger systems, various types of biological treatment including rotating biological contactors merit evaluation. Figures 3-22 through 3-35 are fact sheets which describe wastewater engineering techniques particularly appropriate for small communities. Other techniques described on Figures 3-1 through 3-20 may also be used. Figures 3-36 and 3-37 describe sludge treatment and disposal techniques respectively.

3.2.4 Centralized Systems

The term "centralized systems" is defined here as any collection, treatment and disposal system that can handle more than 100,000 gallons per day of incoming wastewater. Centralized systems have been utilized extensively in the past. They are also complex systems that are generally proven and understood by engineers and designers; therefore, centralized systems are still quite popular and in widespread use, although emphasis on planning of such facilities is declining due to the high cost of construction, operation and maintenance. Like the other previously discussed wastewater management techniques, centralized systems may utilize various types of collection and conveyance techniques to serve lower density centers in the mountain communities. Centralized systems are often not suitable for construction in hilly terrain areas with sparse populations.

TABLE 3-5

DESIGN FEATURES OF LAND APPLICATION TECHNIQUES FOR CLUSTER AND SMALL COMMUNITY SYSTEMS

	Irrigation (including surface or subsurface application)	Rapid Infiltration	Overland Flow	Natural or Artificial Wetlands
Application Technique(s)	Surface-sprinklers, lagoons or pipe distribution Subsurface-perforated pipes	Sprinklers, pipe or ditch distribution	Gravity flow from higher elevation Perforated Plastic pipe Gated irrigation pipes	Gravity, pressure, or sprinklers
Common application rate, inches per week	<1 to 2"/week	20 to 30	2 to 16	Less than 5 for natural wetlands
Land required, acres per 10,000 gal/day applied (not including buffer area, roads or ditches)[1]	1 or more	0.1 or more	1 or more	
Method by which wastewater is ultimately disposed	Groundwater or subsurface runoff to surface water	Groundwater	Groundwater or subsurface runoff to surface water	Multiple
Possible multiple land uses	Agriculture Silviculture Horticulture Recreation	Recreation	Agriculture Silviculture	Agriculture Recreation
Land Slope	Less than 20 percent on cultivated lands	Not critical	2 to 8 percent[2]	Less than 5 percent
Minimum depth to water table	3 to 4 feet	10 ft. unless underdrained	Not critical	Not critical
OMR needs specifically for disposal	1) Temporary storage during wet or cold periods 2) Maintenance of sprinklers 3) Vegetation removal	1) Possibly storage during cold periods 2) Disc or Scarifier for basin 3) Periodic mowing of vegetation	1) Temporary storage during cold weather 2) Vegetation removal	1) Possibly vegetation removal

TABLE 3-5 (cont.)

DESIGN FEATURES OF LAND APPLICATION TECHNIQUES
FOR CLUSTER AND SMALL COMMUNITY SYSTEMS

[1] Assumes 5 days per week of operation

[2] Steeper grades might be feasible with reduced hydraulic loadings

OMR - Operation, Maintenance and Repair

Sources of information: U.S. EPA, 1980 (CD-53) and U.S. EPA, 1981.

TABLE 3- 6

WASTEWATER ENGINEERING TECHNIQUES FOR SMALL COMMUNITY SYSTEMS IN MOUNTAINOUS AREAS

COLLECTION[1]	TREATMENT	DISPOSAL
Gravity Sewers • conventional • small-diameter	Preliminary Treatment	Soil Absorption at community site(s)[2] • Trenches or pits • Beds • Mounds
Pressure Sewers • Septic tank effluent pumps • Grinder pumps		
Vacuum Sewers	Aerobic treatment Rotating Biological contactors Trickling Filters Contact stabilization Extended aeration[4]	Irrigation[3] • crop land • open land • forest land
		Surface waters[3]
	Lagoons Filters[5] Marsh/Pond/Meadow (artificial or natural)	

---

[1] Any sewer system can be designed as a conventional or small-diameter system.

[2] Other soil absorption techniques are available that are variations of the basic absorption techniques (see Figures 3-11 through 3-17).

[3] Disinfection is required prior to disposal.

[4] Extended aeration is a form of the activated sludge process (see Figure 3-32).

[5] Filters can provide for effluent to be recirculated.

TABLE 3-7

WASTEWATER ENGINEERING TECHNIQUES FOR CENTRALIZED SYSTEMS IN MOUNTAINOUS AREAS

COLLECTION	TREATMENT	DISPOSAL
Large diameter Gravity sewers (with pumping stations as needed)	Activated sludge	Irrigation[1] • crop land • open land • forest land
		Surface waters [1]
	Rotating biological contactors	
	Trickling filters	
	Lagoons Filters[2] Advanced treatment processes for nitrogen, phosphorous, carbon, metal and/or organic removal	

---

[1] Disinfection is required prior to disposal.

[2] Filters can provide for effluent to be recirculated.

TABLE 3-8

LIMITING CHARACTERISTICS OF WASTEWATER COLLECTION TECHNIQUES

	Maximum Allowable Land Slope (percent)	Minimum Recommended Depths of Native Soils Below	
		To Water Table	To Bedrock
Gravity Sewers (conventional and small-diameter)	20	2	2
Pressure Sewers (with septic tank effluent pumps or grinder pumps)	20	2	2
Vacuum Sewers	5	6	6

Table 3-7 summarizes the wastewater collection, treatment and disposal techniques most commonly associated with centralized systems. Table 3-8 summarizes some of the natural features which would limit installation of gravity and pressure collection systems. These systems typically consist of large diameter gravity sewers and force mains, pumping stations and elaborate treatment facilities capable of producing a high quality effluent suitable for stream discharge or land disposal via irrigation, rapid infiltration or overland flow. The various wastewater and sludge treatment techniques are described only in broad categories; many manufacturers have developed their own unique treatment processes. Engineering parameters for the design of relatively large centralized treatment techniques have been well studied and tested. Treatment of wastewater to quality levels much higher than secondary treatment can be achieved via processes that convert or remove nitrogen, phosphorus, organic carbon, metals and organic compounds. Many of those engineering techniques which are applicable in small communities are also applicable in large-scale centralized systems.

3.3 Installation/Construction Techniques

Sewage facilities which have been properly sited and designed need to be installed not only according to specifications but by also using appropriate construction techniques. Any one of a number of problems following system design could completely eliminate the system's effectiveness. Such potential problems during installation include:

- installation at a less-preferred location than designed (e.g. a location with concave slopes),
- excessively deep installation of any soil absorption system,
- high soil moisture during installation,
- backfilling causing damage to pipes, tanks, or other buried structures,
- compaction of soil in and around the downslope area, once the pipes or tanks are in place,
- not adhering to specifications such as placement of coarse material beneath pipes or tanks, or leveling of in-ground facilities,
- site damage following preliminary evaluation and design, (e.g. soil removal, compaction),
- construction which does not follow land contours,
- inadequate depths or protection to avoid freezing of in-ground facilities,
- lack of field testing following installation but prior to the contractor leaving the site (such as pressure testing pumps and siphons or water testing a level distribution box),
- insufficient diversion of runoff to avoid infiltration and possible hydraulic overloading.

Methods and reasons for addressing each of these potential problems are presented in Table 3-9 . While there are many potential problems, most can

TABLE 3- 9

METHODS FOR AVOIDING COMMON PROBLEMS FOR INSTALLING SMALL WASTEWATER SYSTEMS

Problem	Methods for Avoiding Problem	Reasons for Avoiding Problem
Installation at a wrong or different location	• Stake out preferred location (s) and layout components prior to installation. • Have a qualified on-site inspector during entire installation. • Review plans and specifications with contractor at the site prior to construction.	• Variable soil conditions (slope, hydraulic conductivity, depths) in a small area • Location of the sewage facility in an untested area may have total, different hydraulic characteristics and result in premature overloading and failure.
Excessively deep installation	• Have a qualified inspector on-site during excavation.	• Shallow available soil depth to water table or bedrock
High soil moisture level during installation	• Require soil moisture test to be performed prior to the start of construction by a qualified inspector or soil scientist.	• High moisture conditins can result in irreversible soil smearing and high reductions in soil permeability
Backfilling causing damage to pipes and tanks	• Lightweight track equipment and backhoes should be utilized to place protective layers of fill on sewage facilities working principally from the upslope side.	• Wastewater loadings can be localized and result in clogging if in particular gravity fed laterals are not level following backfilling operations
Compaction of soil in or around the absorption area	• Work only during dry soil conditions (hand test or soil moisture meter) • Have a qualified on-site inspector to guard against damaging installation practices • Critical downslope areas can be roped or fenced off	• Excavation of trenches, beds and other land disposal systems can result in compactions of downslope area. Movement of water may be restricted due to compaction of down-gradient soils.
Not adhering to specifications such as placement of coarse material beneath pipes or tanks	• Have a qualified inspector on site during installation	• Adhering to specifications can make the differnece between proper performance and failure.

TABLE 3-9 (cont.)

METHODS FOR AVOIDING COMMON PROBLEMS FOR INSTALLING SMALL WASTEWATER SYSTEMS

Problem	Methods for Avoiding Problem	Reasons for Avoiding Problem
Excessive water entering system due to improper seals	• Septic tanks and pumping chambers can be installed during wet periods to check for water tightness (if potential compaction problems can be controlled). • Septic tank and pumping chambers can be filled with water to check for leaks. These facilities can also be checked after rainfall events for inflow around bad seals.	• Extraneous water in the system places a burden on the absorption system and may result in seasonal hydraulic overloading of the system and possible breakout of sewage.
Site damage following preliminary evaluation	• All sites should be inspected prior to the start of construction to verify that the tested site has remained in a natural condition. This means soil has not been disturbed or removed or the site has been damaged by wheel compaction. • Staking, roping and/or fencing off the area immediately following the site evaluation	• Many soil absorption systems are installed or constructed quite some time after the site is evaluated. Soils are frequently compacted by trucks during other construction activities. Topsoil is also sometimes removed as part of general land shaping.
Construction which does not follow contours	• Staking and laying out the system prior to final design	• Trenches, if not properly installed with the contour will result in deep locations at one end and/or shallow settings at the other. Deep excavations may result in the location of laterals in less permeable material or insufficient vertical separation between the bed or trench and limiting or restrictive features (e.g. groundwater or fractured rock).
Inadequate depths to avoid freezing of in-ground facilities	• Require sewers under future driveways to be insulated. Require design to have pressure dosed systems drain back to dosing chamber after cycle.	• Lack of insulation of building sewer under driveways which are cleared of snow may result in freezing. Supply distribution lines in pressurized systems too should be drained between cycles to guard against freezing.

TABLE 3-9 (cont.)

METHODS FOR AVOIDING COMMON PROBLEMS FOR
INSTALLING SMALL WASTEWATER SYSTEMS

Problem	Methods for Avoiding Problem	Reasons for Avoiding Problem
Lack of field testing following installation	• All sewage facilities should be water-tested for leaks as well as operational performance. Distribution and drop boxes can be tested with water for proper discharge.	• Small diameter holes are prone to clogging from leftover construction materials left in laterals, pumping tanks, etc. Cleanouts are recommended on all laterals to facilitate routine maintenance.
Excessive erosion following construction	• Seed and mulch absorption area and provide adequate stormwater diversion to control erosive runoff. • Require final inspection of facilities prior to approval	• Minimum protective covers are usually placed over soil absorption system though properly designed thin cover materials resulting from shoddy backfilling or landscaping may result in surface breakout of sewage and saturation of the absorption area during rainfall events.
Insufficient diversion of runoff to avoid excessive infiltration and possible overloading	• In the case of sloping sites, random fill upslope or separate diversion ditches should be placed. Interceptor drains can be installed to manage stormwater runoff. • Require final inspection of facilities prior to approval	• Soil absorption systems are frequently constructed on hillsides in such a way as to trap storm runoff and promote infiltration and system overload. Final shaping with small lightweight equipment can result in an aesthetically pleasing configuration that promotes runoff instead of infiltration.

30<

be minimized or avoided by application of relatively simple methods. Use of a qualified inspector on-site and good communication between the inspector and the contractor is a method for controlling many potential problems immediately prior to and during installation. Some situations, such as unnecessary soil compaction by the contractor's equipment and inadequate leveling of in-ground facilities, can be controlled by the inspector and the contractor working together. Roping off the proposed absorption area is a simple, effective measure for avoiding unnecessary soil compaction. Leveling of the distribution box is the biggest problem faced by installers in four rural North Carolina counties (Berkowitz, 1981). The absorption beds and trenches need to be aligned at a proper, uniform slope as well. System testing prior to covering the installation is a relatively easy, quick and effective method for avoiding many potential problems.

The methods presented in Table 3-9 are pertinent to various engineering techniques, but the methods are particularly valuable for underground facilities. Once underground facilities are in place and covered, the process of correcting problems suddenly becomes much more costly and time-consuming than if the problem is corrected before burial.

3.4 Operation, Maintenance and Repair

Benefits of proper design and installation of small community systems can be completely overshadowed by improper or infrequent operation, maintenance and/or repair (OMR) activities. Inadequate maintenance is a primary reason cited by North Carolina sanitarians for septic tank system malfunctions (Berkowitz, 1981). Some problems which can develop even in a properly designed and installed system are:

- excessive amounts of water entering the wastewater system resulting in backups to homes or flooding of the disposal site,
- uneven wastewater distribution,
- seepage from the disposal area and surface seepage or breakout, resulting in pollution of ground or surface waters.

In general, the systems with the most hardware and moving parts are those that require the most OMR. However, techniques like a septic tank also require periodic maintenance.

Table 3-10 presents ways that any of the problems listed previously could be solved. Some of the remedies are much less costly and time-consuming than others. Clearly, persons experienced in trouble-shooting wastewater problems would preferably be utilized to assess the type of problem being encountered and to select and implement the remedy with the highest likelihood of being successful. Some of the remedies can be attempted at any time during a year without interrupting system performance, however, other remedies may require use of temporary holding tanks while rehabilitation is in progress. Some remedies also may be successful at certain locations and inappropriate at others. For example, use of hydrogen peroxide to unclog soils is recommended primarily for sandy soils. Inappropriate chemical treatment could be detrimental if the ability of the soil to provide wastewater treatment is lost.

One of the most frustrating problems encountered by a sanitarian is receiving numerous calls for repairs on the same day, perhaps following a

TABLE 3-10

OPERATION, MAINTENANCE AND REPAIR OF SMALL WASTEWATER SYSTEMS

Potential Problem	Possible Remedies
Plumbing back-ups	• Inspect and rehabilitate sewer line extending from establishment. • Inspect septic tank; review maintenance records, check condition of treatment unit, distribution lines and boxes. • With pressurized systems, inspect lateral cleanouts for clogging slime layer back flush. Clean and repair inoperative pump and siphons.
Hydraulic overloading	• Divert runoff around piping and treatment disposal area-regrade surface. • Inspect and rehabilitate septic tank (or other treatment unit). • Seal pipe connections to treatment unit and any other leaks. • Verify that roof drains and other clean water discharges are not connected to wastewater system. • Separate laundry water and dispose of it at a different area. • Increase size of disposal field bed(s) or trench(es). • Institute water conservation measures or reuse techniques. • Retest site, determine depths to restrictive feature; expand, repair or replace absorption area. • Calculate upgradient drainage area and hydraulic capacity of the soil/site.
Surface Seepage or Wetness	• Inspect septic tank pumpout to be sure adequate capacity and outlet protection are in place. Evaluate the following structural remedies: i. Install septic solids retaining devices ii. Install gas deflection baffles iii. Install nonequal volume septic tank iv. Compartmentalize septic tank • Rest absorption area by employing wasteflow reduction/water conservation efforts and periodic pumping of tank • Convert gravity flow system to pressure dosing for more uniform distribution and resting. • Retest soils on the site, increase absorption area based on present day wastewater generation e.g. clays and clay loom 0.1 gals/fts up to 0.5 gals/fts for looms and other fine textured soils. • Provide additional wastewater treatment (install aerobic treatment unit) • Reduce amounts of water entering the wastewater system. Check plumbing figures. • Discontinue use of garbage disposal. • Chemical treatment (e.g. hydrogen peroxide) as suitable. • Avoid disposal of certain industrial wastes that can contribute to clogging.

TABLE 3-10(cont.)

OPERATION, MAINTENANCE AND REPAIR
OF SMALL WASTEWATER SYSTEMS

Potential Problem	Possible Remedies
Poor Wastewater Distribution	• Check distribution or drop box for: i. level outlets - water test ii. clogged or broken outlets • Check laterals in supply distribution system, replace or relevel using smaller diameter pipe with fewer small diameter discharge holes. • Install sewage effluent pump or siphon to distribute wastewater through small diameter laterals and holes. • Clean distribution network by rodding and backflushing.
Pollution of Underlying Groundwater (or downstream surface water)	• Pump out septic tank(s) (or maintain other types of treatment units). • Provide additional wastewater treatment. • Modify absorption area to provide a layer of less permeable soil filter material. • Repair/replace water supply well casing(s)

NOTE: See also Section 3.5 which describes techniques to enhance system performance.

large rainfall. A program of periodic inspection and homeowner interviews could greatly reduce such problems, before they become hazardous or otherwise noticeable to the homeowner.

The most common on-site maintenance procedure is pumping out septic tanks. As sludge accumulates in a septic tank, the capacity of the tank to hold and treat incoming wastewater decreases and the quantity of solids leaving the septic tank increases. These solids can clog the soil at the disposal location and unnecessarily pollute the groundwater or a nearby stream or lake. Pumping out septic tanks periodically helps to avoid such problems.

The septage or sludge which is pumped from the tank is a fluid mixture of partly digested sewage solids and liquids. It has typically been disposed of in rural areas by discharge into a community treatment facility, but the distance to such facilities often results in septage being discharged without control to woodland, farms and streams.

Because septage contains small quantities of nitrogen, phosphorus, potassium and other trace elements that are nutrients for plant growth, it can be beneficially used if correctly managed. In this way material that has been a disposal problem can become an economic resource. There are various ways in which septage can be reused including composting and injection or controlled application to land.

The most important requirements for the successful use of septage in normal farming operations are landowner arrangements, public acceptance, and a cooperative relationship with municipal officials and regulatory agencies. Farmers willing to cooperate and use septage in their normal farming operations must be located and suitable fields selected. Travel distances and road conditions are important factors to a septage hauler, but field conditions, crops, and timing of application are more important to the farmer.

A septage hauler should have several alternate sites available on which he can spread the sludge if, for any reason, the preferred site is unavailable. The number of sites and total acreage depend on the amount of septage that he expects to haul. Guidelines for septage loadings are normally provided through the local agricultural extension office and the state regulatory agency.

Septage should be applied on agricultural land as uniformly as possible, either in a thin surface application or through subsurface injection. If it is applied on the surface it should be plowed under within 24 hours to control odors and eliminate nuisance complaints.

The use of septage in normal farming operations may provide an economical method of disposal for the hauler during serveral months of the year, but there are extended periods during which other methods of management and disposal will be required. One alternative would be to locate one or more municipal wastewater treatment plants that will accept this material for treatment and final disposal. If haulers cannot make satisfactory arrangements with a treatment plant, they may have to construct holding ponds where the septage can be stored temporarily until conditions are more suitable for agricultural use.

There are many municipalities in EPA Region IV that are spreading sludge and septage on agricultural lands. The following is a sample of municipal treatment plants that are involved with the application of sludge to crop and forest lands:

- Augusta, GA
- Coneyville and Leitchfield, KY
- Organa, NC
- Morganton, NC
- Spartanburg, SC
- Woodbury, TN

During the wet weather months when application of dry or wet sludges cannot be made, anaerobic sludge and septage can be dewatered and composted. Sludge and septage have been successfully composted using static piles and windrows to produce a biologically stable product suitable for use in landscaping, horticulture turfgrasses and on agricultural crops. The following is a list of treatment facilities which are managing sludge by composting:

- Lexington, KY
- Durham, NH
- Washington, DC
- Beltsville, MD
- Manassas, VA
- East Richland County, SC

On farms, livestock wastes and domestic wastes have also been used to produce biogas to heat poultry houses, greenhouses and dairy parlors. Biogas can also be compressed to methane for fueling farm equipment and powering electrical generators. Methane cogeneration has also been successfully used in conjunction with municipal treatment plant anaerobic digestors. A treatment facility in Los Angeles, for example, is producing 25 megawatts of electricity from this method. In the study area, Henderson, NC, is recovering methane gas from this type of process.

Sludge and septage have also been used successfully to revegetate disturbed lands. In Pennsylvania, strip mined areas were successfully revegetated with a mixture of dewatered sludge cake and composted sludge. Vegetative covers have persisted for periods up to five years without deterioration (Sopper, 1984). Similar projects have been completed in Kentucky and other Appalachian coal fields with improved strip mine spoil and leachate quality.

The recommended minimum frequency for pumping out septic tanks varies depending upon the size of the tank, flow of wastewater entering the tank and the solids content of the wastewater. Assuming a minimum wastewater residence time within a tank and assuming a certain percentage of the retained solids are decomposed, minimum pumpout frequencies can be estimated. Table 3-11 lists estimated pumpout frequencies assuming a minimum wastewater residence time of 24 hours and assuming 50 percent of the solids are decomposed (digested). If six people reside in a three bedroom home with a 900 gallon septic tank, the tank should be pumped at least every 1.3 years. If the same tank serves a family of two, the tank should be pumped at least every 5.2 years. Smaller tanks need to be pumped more often for the same household size. Lack of any inspection and maintenance allows structural deficiencies to go unnoticed and possibly jeopardizes the absorption system. In septic tanks and pumping chambers bad seals and cracks which go uncorrected may allow significant amounts of groundwater to infiltrate and overload the system. Baffles which are no longer functional or in their proper location may be permitting significant amounts of undetected solids to pass into the absorption area.

Many current designs are not hydraulically sound in that too little attention is paid to reducing in-tank turbulence and attenuating peak discharge rates.

Septic tank designs can be modified so as to produce an inlet and outlet device which will be efficient and long-lasting in a highly corrosive environment. Inspections made during the repair process often find baffles on the bottom of the tank that have deteriorated and fallen off. This condition then allows grease and solids to flow into the soil absorption area, possibly clogging the soil.

Septic tanks should be constructed in two compartments or have tanks of unequal volume installed in series. Initally, these methods result in better anerobic waste digestion. However, if sludge (which accumulates more quickly in the first tank or compartment) continues to accumulate without pumping, a sewage backup will occur. Unless sludge is removed before a back-up occurs, it can cause solids to flow into the absorption field, clogging the field and causing failure of the system.

Inspection ports on septic tanks extended to the ground surface can help facilitate maintenance checks. Current installation practices encourage users of septic tanks to forget them, because most are deeply buried without inspection ports or access manholes. Incorporation of ports or manholes would serve to continuously remind the users of the location of the facilities and allow ready access for maintenance. Utilizing cleanouts as depicted on Figure 3-38 can aid in the location of distribution laterals and aid in routine maintenance (e.g. flushing).

Wastewater engineering techniques for clusters of establishments, small communities and centralized systems have more frequent maintenance needs than do typical on-site systems. Sewers should be flushed and periodically inspected. Treatment units need at least weekly inspections; more sophisticated treatment units need even more intense monitoring and adjustment. Techniques which require energy and/or chemical inputs have particularly frequent maintenance needs. Types of OMR activities for cluster, small community and centralized wastewater systems are described in Table 3-12. These OMR activities are currently best understood and implemented for the centralized systems, in part because a small number of trained persons can concentrate on a handful of centralized facilities. Budget constraints for maintaining numerous small systems and the seemingly minor effect of a malfunctioning small system contribute to lower prioritization of OMR activities for small systems, even though OMR needs are much more intensive for centralized systems. Operation, maintenance and repair of small systems deserves more emphasis in terms of budget and trained personnel than they have received in the past.

Many current designs are not hydraulically sound in that too little attention is paid to reducing in-tank turbulence and attenuating peak discharge rates.

Septic tank designs can be modified so as to produce an inlet and outlet device which will be efficient and long-lasting in a highly corrosive environment. Inspections made during the repair process often find baffles on the bottom of the tank that have deteriorated and fallen off. This condition then allows grease and solids to flow into the soil absorption area, possibly clogging the soil.

Septic tanks should be constructed in two compartments or have tanks of unequal volume installed in series. Initally, these methods result in better anerobic waste digestion. However, if sludge (which accumulates more quickly in the first tank or compartment) continues to accumulate without pumping, a sewage backup will occur. Unless sludge is removed before a back-up occurs, it can cause solids to flow into the absorption field, clogging the field and causing failure of the system.

Inspection ports on septic tanks extended to the ground surface can help facilitate maintenance checks. Current installation practices encourage users of septic tanks to forget them, because most are deeply buried without inspection ports or access manholes. Incorporation of ports or manholes would serve to continuously remind the users of the location of the facilities and allow ready access for maintenance. Utilizing cleanouts as depicted on Figure 3-38 can aid in the location of distribution laterals and aid in routine maintenance (e.g. flushing).

Wastewater engineering techniques for clusters of establishments, small communities and centralized systems have more frequent maintenance needs than do typical on-site systems. Sewers should be flushed and periodically inspected. Treatment units need at least weekly inspections; more sophisticated treatment units need even more intense monitoring and adjustment. Techniques which require energy and/or chemical inputs have particularly frequent maintenance needs. Types of OMR activities for

40

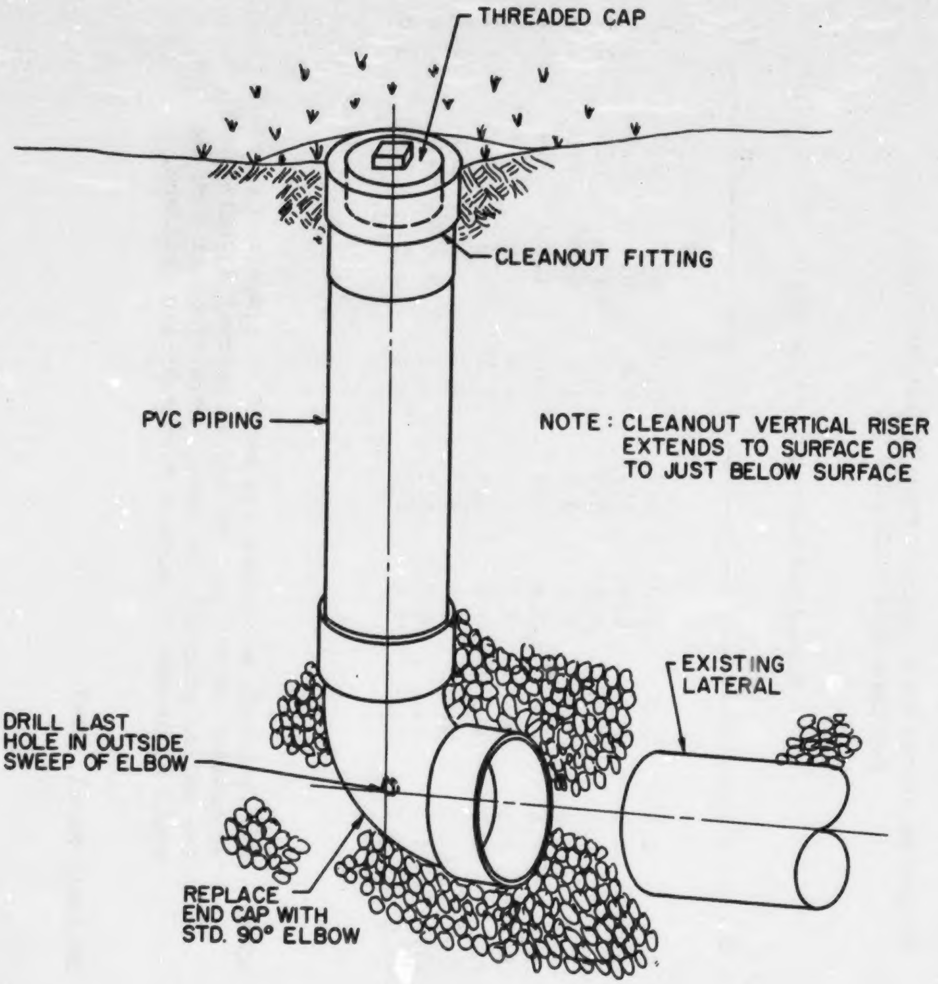
TABLE 3-11

ESTIMATED SEPTIC TANK PUMPING FREQUENCIES (IN YEARS) FOR YEAR-ROUND RESIDENCES

Tank Size (gal)	Household Size (No. of people)									
	1	2	3	4	5	6	7	8	9	10
500	5.8	2.6	1.5	1.0	0.7	0.4	0.3	0.2	0.1	-
750	9.1	4.2	2.6	1.8	1.3	1.0	0.7	0.6	0.4	0.3
900	11.0	5.2	3.3	2.3	1.7	1.3	1.0	0.8	0.7	0.5
1000	12.0	5.9	3.7	2.6	2.0	1.5	1.2	1.0	0.8	0.7
1250	16.0	7.5	4.8	3.4	2.6	2.0	1.7	1.4	1.2	1.0
1500	19.0	9.1	5.9	4.2	3.3	2.6	2.1	1.8	1.5	1.3
1750	22.0	11.0	6.9	5.0	3.9	3.1	2.6	2.2	1.9	1.6
2000	25.0	12.0	8.0	5.9	4.5	3.7	3.1	2.6	2.2	2.0
2250	29.0	14.0	9.1	6.7	5.2	4.2	3.5	3.0	2.6	2.3
2500	32.0	16.0	10.0	7.5	5.9	4.8	4.0	4.0	3.0	2.6

NOTES: The frequency estimates are based on a minimum 24-hour wastewater retention time and 50 percent digestion of the solids entering the tank. More frequent pumping would be needed if garbage disposals are utilized.

Source: Mancl, 1983.


THREADED CAP
CLEANOUT FITTING
PVC PIPING
NOTE: CLEANOUT VERTICAL RISER EXTENDS TO SURFACE OR TO JUST BELOW SURFACE
EXISTING LATERAL
DRILL LAST HOLE IN OUTSIDE SWEEP OF ELBOW
REPLACE END CAP WITH STD. 90° ELBOW

INSTALLATION OF LATERAL CLEANOUT

FIGURE 3-38

cluster, small community and centralized wastewater systems are described in Table 3-12. These OMR activities are currently best understood and implemented for the centralized systems, in part because a small number of trained persons can concentrate on a handful of centralized facilities. Budget constraints for maintaining numerous small systems and the seemingly minor effect of a malfunctioning small system contribute to lower prioritization of OMR activities for small systems, even though OMR needs are much more intensive for centralized systems. Operation, maintenance and repair of small systems deserves more emphasis in terms of budget and trained personnel than they have received in the past.

3.5 Enhancement Techniques for Small Wastewater Systems

There are certain engineering techniques that can improve system performance which would, in all likelihood, not be evaluated when a system is in need of quick repair. Such techniques, called enhancement techniques in this report, can be highly cost-effective and implemented either before a new system is installed or after significant modifications to an existing system are deemed necessary.

Practices within the home or business that can enhance performance of any wastewater system include:

- use of water saving devices (see Figure 3-39),
- avoiding or discontinuing use of garbage disposals,
- using grease traps,
- separating toilet wastes (blackwater) from other wastewaters (greywater) (see Figure 3-40),
- diverting roof runoff away from wastewater system.

The most common and inexpensive watersaving devices are low-flow shower heads, low-flush toilets and pressure-reducing valves. Existing shower heads and toilets can be easily modified to reduce shower and toilet water use by as much as 60 percent; shower heads and faucets often account for 60 to 70 percent of average daily water use at a typical year-round or seasonal household. Discontinuing use of garbage disposals and initiating use of grease traps can be an inconvenience at first. However, reduction of solids and grease loadings to the wastewater system can reduce wastewater system maintenance and repair costs, thereby benefiting the homeowner. Separating blackwater and greywater is far more costly than the other enhancement techniques utilized within the home or business. This technique may lessen a problem with hydraulic overloading, but may pose problems with treatment of the greywater fraction. Toilets which compost or incinerate wastes with minimal water use are also available. Blackwater-greywater separation and composting or incinerating toilets have been tested but not extensively implemented largely because of their relatively high costs.

TABLE 3- 12

OPERATION, MAINTENANCE AND REPAIR (OMR) ACTIVITIES FOR CLUSTER, SMALL COMMUNITY AND CENTRALIZED WASTEWATER TECHNIQUES

Technique	OMR Activities	Typical Service Life, Years	Preferred Minimum Frequency of OMR Activity
Pumps	Inspection and Lubrication	10 to 20	Monthly
Pipelines	Flushing	30 to 40	Every 2 to 3 years
Septic Tank	Pumpout	30 to 40	Typically 1 to 5 years (see Table 3-10)
Filters	Backwash	20	Daily to weekly
Other treatment systems	Operate total system and remove sludge	20	Daily to weekly
Underground disposal	Monitor from above ground following wet period and period of abnormal usage	20	Every 1 to 2 years
Above ground land disposal	Maintain nozzles (irrigation) Monitor wastewater distribution and infiltration	10 to 20	Weekly
Discharge to surface water	Comply with discharge permit requirements	20	Weekly

The performance of septic tanks, absorption beds on trenches and irrigated fields can be enhanced with one of a number of techniques, all of which require design, installation and maintenance:

- multi-compartment or multiple septic tanks or other treatment units in series,
- pressure dosing of beds or trenches to evenly distribute disposed wastewater,
- alternating use of two or more beds, trenches or fields (e.g. on a hillside to allow disposal areas to dry out periodically),
- use of intercepting or curtain drains to reduce infiltration from surface runoff to disposal area (see Figure 3-41),
- fewer and smaller diameter distribution pipes and discharge holes to promote more even distribution of effluent,
- for rapidly permeable coarse-textured soils, e.g. sands and gravels, a "sandwich" of loam on silt 6 to 18 inches thick included in the total vertical thickness to enhance wastewater treatment,
- shallow placement of disposal pipes (as close as 12 inches from the soil surface) if the upper layer of soil is relatively permeable and the water table or bedrock is 3 to 5 feet below the soil surface,
- use of distribution boxes in lieu of headers, drop boxes, serial or step down distribution techniques.

All of these techniques have been tested and effectively utilized at least on an experimental basis; engineers who have designed such techniques are available.

In addition, more frequent maintenance of any wastewater facilities than is minimally recommended (e.g. annual pumpout of septic tanks) and frequent inspection of facilities can thwart potential problems and effectively increase service lives of facilities. Systems which are utilized only intermittently should preferably be inspected each time their use is reinitiated.

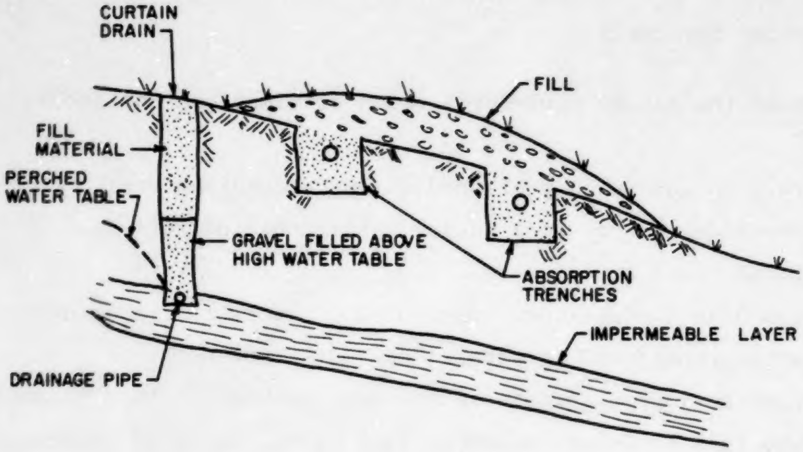
3.6 Preferred Design Practices

Public health department professionals, engineers, soil scientists and sanitarians can more effectively design small systems if certain practices are followed. Many such practices are not particularly costly in light of the potential benefits to be gained.

Proper training is an important pre-requisite for any designer. This includes periodic training updates to assimilate evolving practices. Some states require individuals to be properly trained before the individuals can supervise or conduct a system design. Admittedly, quality control of numerous small system designers can be more difficult than for a handful of large system designers.

Some of the design procedures which at times are improperly conducted include:

- relying solely on published soils information from the local county soil survey rather than performing field tests at the site,
- poor site evaluations, including failure to assess impacts of surface water runoff and internal groundwater movement,
- poor soil profile description made by nonqualified personnel who fail to detect seasonal high water tables as evidenced by soil discoloration (e.g. gleying or mottling) and who fail to locate and properly describe restrictive features, e.g. slowly permeable layers and fractured rock,
- improper assessment of the soil's ability to accept and properly renovate wastewater effluents, particularly, failure to determine whether or not sufficient soil exists in profiles having high volumes of rock fragments,
- failure to determine the overall site characteristics due to the lack of sufficient soil testing (either back hoe test pits or hand auger borings),
- failure to consider different effluent quality characteristics from different types of uses, e.g. restaurants vs residential,
- failing to design treatment units and absorption system for long-term performance. Systems are designed typically by using


CURTAIN DRAIN
FILL
FILL MATERIAL
PERCHED WATER TABLE
GRAVEL FILLED ABOVE HIGH WATER TABLE
ABSORPTION TRENCHES
IMPERMEABLE LAYER
DRAINAGE PIPE

NOTE: CURTAIN DRAIN IS USED TO INTERCEPT LATERALLY MOVING PERCHED WATER TABLE CAUSED BY A SHALLOW, IMPERMEABLE LAYER.

SOURCE: KENTUCKY CABINET FOR HUMAN RESOURCES, 1982

CURTAIN DRAIN

FIGURE 3-41

State Regulations and Codes as the sole basis of design; these guidelines are often only meant to serve as guidelines for establishing minimum requirements,

- failure to correlate soil characteristics with permeability test results. Differences in percolation test hole construction and presoaking techniques lead to variable test results. Designers should use percolation test results with care, particularly when working with fine textured soils (e.g. loams and clay loams). Test results may not be truly representative, because soil percolation tests are conducted with relatively clean water, free of solids and nutrients. Designers should be conservative with establishing wastewater loadings and consider the long term acceptance rate of the soil.
- failure of designers to fully adapt a wastewater system to the site. Errors are made with mismatching absorption system geometry with site conditions which often results in localized overloading of the soil and possible groundwater mounding and flooding.
- designers sometimes fail to understand the impacts of soil characteristics relating to installation. Some designers fail to consider the use of more permeable soil horizons for placement of wastewater distribution networks.
- improper installation or construction of the sewage facility in an area not previously tested or with insufficient separation from water supplies such as wells, springs or other water ways,
- failure of designers to consider techniques which can be implemented in the field to make gravity-feed systems perform better (e.g. specifying discharge hole diameters and spacing for wastewater distribution network),
- failing to project flow inputs for the life of the proposed facility,
- not matching recommended design parameters to the prescribed field conditions (e.g. size of absorption area or distance to water supply well or spring),
- improper siting (e.g. upslope of a water supply well or within a poorly drained soil).
- Failure to consider variations in effluent quality from residential applications to commercial/industrial applications.

Many of the problems that result from improper design procedures can be avoided without incurring large expenses. The recommended values shown in Tables 3-2, 3-5 and 3-8 should be followed. In addition, certain design techniques can be followed such as:

- considering modifications in wastewater applications techniques for gravity systems with one of the methods described in Section 3.5,
- providing cleanout access to sewer pipes at periodic intervals (usually every 100 feet at a maximum),
- avoiding sewer pipe bends of greater than 45 degrees ahead of the septic tank or other type of treatment unit,
- qualified supervision of design procedures by a trained local health department staff,
- properly conducted soil permeability testing often allowing 24-36 hours of presoaking for fine textured soils (e.g. clay loams),
- comparing measured soil percolation test results with published soil permeabilities for U.S.D.A. established soil series,
- performing comprehensive soil testing to more accurately describe soils and potential restrictive features in the proposed absorption area.

To adequately evaluate suitability of soil conditions for a proposed soil absorption system requires the determination of the presence and location of restrictive soil features such as slowly permeable sub soil layers, fractured rock and high groundwater elevations. A detailed description of recommended procedures for carrying out an adequate site soils survey has been included as Appendix II-A to this volume.

Conversely, there are site conditions for which use of certain wastewater techniques should not be made due primarily to public health and environmental constraints. Soils which do not have a well-structured and drained profile for at least 2 to 4 feet should not ordinarily be used for soil absorption treatment and disposal systems. However, some types of systems can be constructed on these marginal soils with special siting, design and construction as illustrated on Figures 3-11 through 3-18. In terms of costs and benefits, the avoidance of adverse impacts produced when untreated wastewater rises to the soil surface or reaches a water supply may be well worth the extra cost of instituting a cluster or other type system in locations where soil or other conditions are not suitable to on-site disposal. Such areas should be designated and enforced as not being usable for land disposal techniques before systems are designed and installed, if possible. Public management and authority can help greatly to enforce restrictions on use of land disposal techniques.

3.7 Evaluation of Alternative Engineering Techniques

The engineering techniques discussed in Sections 3.2 through 3.5 can be utilized for both new development and for rehabilitation of existing wastewater systems. In either case the objective is to select the most cost-effective alternative which will reliably remove harmful constituents from the wastewater and produce an effluent of sufficient quality to be disposed of to either the land or water without causing environmental quality or public health impacts.

A reasonable method for selecting the most appropriate engineering technique for a given community would be to consider alternatives in order of increasing complexity. The least complex techniques are typically least expensive, are most straight-forward to install, and require the least amount of OMR. However, the simplest techniques will not be appropriate for all communities. In some locations more complex systems may be needed to ensure adequate performance because of factors such as community population density, growth projections, or natural features. The system must still be within the financial and operational capability of the owner.

Figure 3-42 illustrates a method which may be used for selecting engineering techniques for new development by considering the most basic systems first. Simple individual on-site techniques are often the least costly wastewater management methods (U.S. EPA, 1982b as an example). These simplest techniques should be evaluated first, particularly for sparsely-populated areas. The most critical design parameters for any land treatment and disposal system are:

- depths to water table and bedrock,
- size of absorption area given soil permeability, and peak wastewater flows,
- land slope,
- distances and flow potential to water supply, stream or adjacent property, and,
- lot size.

RECOMMENDED METHODOLOGY FOR SELECTING PREFERRED ENGINEERING TECHNIQUES FOR NEW SYSTEMS

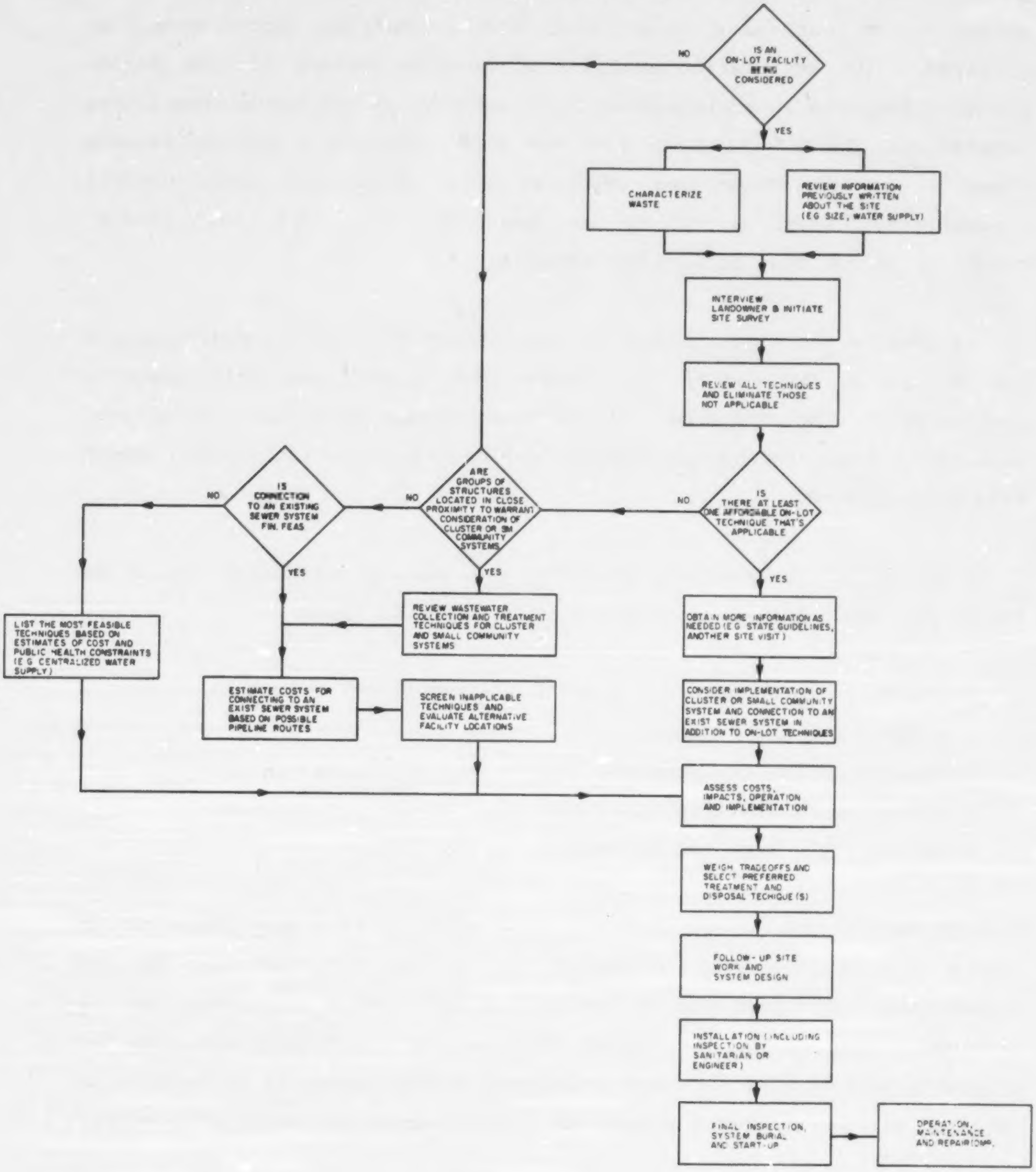

IS AN ON-LOT FACILITY BEING CONSIDERED
NO
YES
CHARACTERIZE WASTE
REVIEW INFORMATION PREVIOUSLY WRITTEN ABOUT THE SITE (E.G. SIZE, WATER SUPPLY)
INTERVIEW LANDOWNER & INITIATE SITE SURVEY
REVIEW ALL TECHNIQUES AND ELIMINATE THOSE NOT APPLICABLE
IS THERE AT LEAST ONE AFFORDABLE ON-LOT TECHNIQUE THAT'S APPLICABLE
NO
YES
ARE GROUPS OF STRUCTURES LOCATED IN CLOSE PROXIMITY TO WARRANT CONSIDERATION OF CLUSTER OR SM COMMUNITY SYSTEMS
NO
YES
IS CONNECTION TO AN EXISTING SEWER SYSTEM FIN. FEAS
NO
YES
LIST THE MOST FEASIBLE TECHNIQUES BASED ON ESTIMATES OF COST AND PUBLIC HEALTH CONSTRAINTS (E G CENTRALIZED WATER SUPPLY)
REVIEW WASTEWATER COLLECTION AND TREATMENT TECHNIQUES FOR CLUSTER AND SMALL COMMUNITY SYSTEMS
ESTIMATE COSTS FOR CONNECTING TO AN EXIST SEWER SYSTEM BASED ON POSSIBLE PIPELINE ROUTES
SCREEN INAPPLICABLE TECHNIQUES AND EVALUATE ALTERNATIVE FACILITY LOCATIONS
OBTAIN MORE INFORMATION AS NEEDED (E.G. STATE GUIDELINES, ANOTHER SITE VISIT)
CONSIDER IMPLEMENTATION OF CLUSTER OR SMALL COMMUNITY SYSTEM AND CONNECTION TO AN EXIST SEWER SYSTEM IN ADDITION TO ON-LOT TECHNIQUES
ASSESS COSTS, IMPACTS, OPERATION AND IMPLEMENTATION
WEIGH TRADEOFFS AND SELECT PREFERRED TREATMENT AND DISPOSAL TECHIQUE(S)
FOLLOW-UP SITE WORK AND SYSTEM DESIGN
INSTALLATION (INCLUDING INSPECTION BY SANITARIAN OR ENGINEER)
FINAL INSPECTION, SYSTEM BURIAL AND START-UP
OPERATION, MAINTENANCE AND REPAIR(OMR)

FIGURE 3-42

Sources for information on these constraints and constraints related to public wastewater facilities are presented in Table 3-13. Any of these constraints can eliminate consideration of on-site systems based on state public health and environmental quality regulations. If such state guidelines do not exist, guidelines from neighboring states should be utilized. The engineering analysis of on-site systems for any establishment requires an evaluation of site constraints and prevailing siting regulations. Table 3-14 lists five key site constraints and the various types of on-site techniques which will be implemented under various constraints. Where an "X" is not shown on Table 3-14, that on-site technique is not considered implementable.

If on-site techniques cannot be implemented or if needed modifications make on-site systems costly, then larger-scale cluster and small community systems need to be evaluated. If the establishment is within a reasonable distance of a municipal sewer system, then connection to that system should also be evaluated.

Ideally, all potentially suitable engineering techniques should be evaluated simultaneously for each of four basic factors:

- costs, in terms of present worth and annual costs with or without a grant or loan,
- impacts on the environment,
- operation of the technique, and
- implementation of the technique.

Considerations related to each of these four factors are presented in Tables 3-15 through 3-18. Clearly, the process of evaluating various engineering techniques can be quite complex. Many parameters can be involved. Cost is the only factor that can be quantified, although the evaluator must be sure that each quantified dollar amount is suitable to be compared with other costs presented. Definitions and methodologies for

54<

evaluation analyses are presented in other EPA guidance documents (U.S. EPA, 1980d and U.S. EPA, 1982a). Judgment is always required when costs, impacts, operation and implementation are being compared.

Conceivably, all wastewater engineering techniques except simple on-site systems could be too costly or not desirable for other reasons. If this type of conclusion is made, some options still exist:

- install the wastewater system (with proper inspection and periodic maintenance) and avoid use of adjacent water supply wells, or
- use holding tanks for the short-term time periods when the on-site wastewater system fails.

Figure 3-42 presents a methodology which has a number of steps (in squares) and decision points (in diamonds) in order to allow all feasible wastewater techniques to be evaluated. Too often affordable, suitable techniques are not evaluated only because they were never considered. If a planner properly utilizes Figure 3-42, that planner must consider on-site, cluster, small community and centralized wastewater techniques. Steps that can be difficult in Figure 3-42 include defining which systems are "applicable" and then weighing the trade-offs amongst all "applicable" techniques. The planner should not need to assess costs, impacts, operation and implementation of more than three or four types of systems, but defining those that are most "applicable" should not be made arbitrarily. Applicability of all but the most complex and costly on-site techniques is based primarily on site conditions presented in Table 3-13. Applicability of cluster, small community and centralized systems depends largely upon costs for both installation and operation compared to the benefits of avoiding on-site techniques. Weighing the trade-offs among the "applicable" should involve non-judgmental, co-equal consideration of costs, impacts, operation and implementation.

TABLE 3- 13

CONSTRAINTS WHICH MAY AFFECT THE SELECTION OF APPROPRIATE ENGINEERING TECHNIQUES

Type of Facility	Factor to Consider	Sources of Values
On-Site Systems and community land disposal sites (for wastewater and sludge)	Soil characteristics and permeability	Based on state guidelines
	Depth to water table	"
	Depth to bedrock	"
	Land slope (e.g. concave or convex, percent slope)	"
	Costs to control runoff through the site from upstream locations	Dependent upon site conditions
	Separation distances (wells, surface waters, springs, terraces, property boundaries, buildings subsurface drainage)	Based on state guidelines
	Water supply well(s) and wastewater system location in relation to predominant direction and speed of groundwater movement	Based on site conditions
	Land area available as compared to land area required to properly handle loadings	Depends upon number of persons served, soil characteristics, state loading guidelines and local land use.
Sewers and treatment plants	Depths to bedrock and water table (important to assess costs)	Dependent upon local conditions.
	Land slope	"
	Available land area as needed for right-of-way	Dependent upon local conditions

TABLE 3-14

VARIOUS SITE CONSTRAINTS WHICH WILL
AFFECT SELECTION OF DISPOSAL TECHNIQUES

Method	Site Constraints											
	Soil Permeability			Depth to Bedrock			Depth to Water table		Slope			Small Lot Size
	Very Rapid	Rapid-Moderate	Slow-Very Slow	Shallow and Porous	Shallow and Nonporous	Deep	Shallow	Deep	0-5%	5-15%	15%	
Trenches		X	X^{2}			X		X	X	X	X	X^{4}
Beds		X				X		X	X			X
Pits		X				X		X	X	X	X	X
Mounds	X	X	X	X	X	X	X	X	X	X		
Fill Systems	X	X^{1}	X^{1}	X	X	X	X	X	X	X	X	X^{4}
Sand-Lined Trenches or Beds	X	X	X^{2}			X		X	X	X^{3}	X^{3}	X^{4}
Artificially Drained Systems		X				X	X		X	X	X^{3}	
Evaporation Infiltration Lagoons		X	X^{5}			X		X	X			
Evaporation Lagoons (lined)^{4,5}	X	X	X	X	X	X	X	X	X			
ET Beds or Trenches (lined)^{4,5}	X	X	X	X	X	X	X	X	X	X^{6}		
ETA Beds or Trenches^{4}		X	X			X		X	X	X	X	X

[1] Only where surface soil can be stripped to expose sand or sandy loam material.
[2] Construct only during dry soil conditions. Use trench configuration only.
[3] Trenches only.
[4] Flow reduction suggested.
[5] High Evaporation potential required.
[6] Recommended for south-facing slopes only.

ET-evapotranspiration
ETA-evapotranspiration and absorption

X means system can function effectively with that constraint.

TABLE 3-15

COSTING CONSIDERATIONS

- Year(s) of installation for future facilities. Staged construction merits evaluation
- Utilize local labor rates and equipment costs as much as possible. These rates and costs should be comparable by being consistent in terms of inflation and regional cost variations, and they should also be as up-to-date as possible
- Costs for facilities with different service lifes can be compared by taking into account salvage values at the end of a designated planning period (usually 20 to 30 years in length)
- Useful lifes of existing and possible future facilities need to be quantified
- The interest rate for estimating future costs should be up-to-date. If a particular type of low-interest loan is realistically available, such a low interest rate could be factored into the calculations
- Capacities for future development should be based on approved state, regional or county population projections. Assumptions about reserve capacity for future connections to service lines can be difficult to make and controversial
- In planning for a facility, may want to consider that grant eligibility varies from component to component of that facility
- Land may need to be acquired or leased
- Completed cost estimates cannot be assumed to have an accuracy of better than plus or minus 5 to 10 percent, particularly for future costs related to future development.

TABLE 3-16

ENVIRONMENTAL FACTORS THAT ARE IMPORTANT IN THE SELECTION PROCESS

Types of Impacts	
Population and Land Use	• Management of systems for future establishments • Management of systems for seasonal vs. year-round residences and tourist businesses • Availability of current land use information • Projected effects of public sewers on land use patterns (e.g. effects on prime agricultural lands) • Potential for development of floodplains, wetlands, prime agricultural lands
Groundwater and Surface Water Resources	• Projected effects on potable groundwater supplies particularly due to land disposal of wastewater • Projected effects on uses of local and downstream surface waters (e.g. recreation, water supply, fish and wildlife) • Wasteload allocations and discharge treatment requirements of state agencies • Effects of installing sewer lines and treatment facilities due to runoff during construction, including stream crossings and construction near water courses • Conditions of springs and water supply well casings and proximity to wastewater facilities • Evaluation of methods to reduce adverse impacts on water quality
Biological Resources	• Presence of endangered or threatened species and projected effects of wastewater facilities • Effects on hunting and fishing • Effects due to construction activities
Economics and Employment	• Availability of water and sewer facilities for industry and/or tourist development in relation to availability of other public services
Archaeological-Historical Resources	• Effects on recorded sites • Evaluation of methods to avoid recorded sites
Odor	• Methods to manage any potential odor problems due to system malfunctions.

TABLE 3-17

OPERATION CONSIDERATIONS FOR ALTERNATIVE WASTEWATER ENGINEERING SYSTEMS FOR RURAL AREAS

	Individual On-Site Systems	Cluster and Small Community Systems	Connect to an Existing Centralized System
ADVANTAGES	Systems are not complex to design install or maintain. Maintenance is only needed every 1 to 5 years. Better sitings, designs and installation procedures extends the use of both inground or above ground absorption systems over valuable soil and site conditions. Energy and chemical needs are minimal.	Better treatment of wastewater can be provided than from on-site systems. Wastewater from households with a density greater than three households per acre can be properly treated and disposed. Discharges of treated wastewater to surface waters, if permitted, can be operated regardless of climate conditions.	Only relatively infrequent inspection and maintenance of facilities is required. Sewers are neither sophisticated nor complex to install unless sufficient depth to bedrock is not available. Maintenance access to larger sewers is better than for small community sewers.
DISADVANTAGES	Lot sizes less than one-third of an acre on lots with shallow soil depths or slowly permeable soils should not be utilized. A large number of systems need to be maintained. Experience with mound systems for use in marginal soils is limited in the EPA Region IV states. Periodic maintenance cannot be enforced without a managing entity that has enforcement powers. Inspection to determine cause of failure and even whether a failure is occurring is difficult, because most or all of the system is beneath the soil surface.	Weekly or more frequent operation and maintenance are required. Additional qualified staff may be needed. Discharge permits and effluent monitoring may be needed. Shallow depth to bedrock can inhibit sewer installation. Energy and chemical usage can be much greater than for on-site systems; standby supplies are also needed. More sludge needs to be processed and disposed than for on-site systems.	Costs are often quite high for sewer installation. Energy usage can be particularly large. Additional treatment capacity at the municipal wastewater treatment plant is required.

TABLE 3-18

IMPLEMENTATION CONSIDERATIONS FOR ALL TYPES OF WASTEWATER SYSTEMS

Local, State and Federal guidelines or requirements	• Individual on-site system design and installation requirements (local or state) • Discharge permits for treatment plants and corresponding treatment requirements (state) • Consistency with regional plans and local land use policies
Financing	• Federal, regional or state grant eligibility and administrative requirements (see Chapter 5) • Loan eligibility and administrative requirements (see Chapter 5) • Assessing ability to pay given existing debt and grant loan eligibility
Public and agency perception and involvement	• Ability and willingness to pay for local share • Access to private on-site systems for maintenance and repair • Public perception of impacts on water supply, public health and the natural environment • Feasibility of long-term use of private lands for community wastewater or sludge disposal
System management	• Designation of the agency responsible for installation, operation, maintenance and repairs. • Value and content of a separate management entity with enforcement authority (see Chapter 4)

Certain county, regional and state professionals can likely assist in providing specific types of information important to assessing types of wastewater facilities. Such professionals include:

- town or county water, sewer and solid waste departments,
- county health department and sanitarians,
- local or county planning agency (land use information) and tax assessor (lot characteristics),
- state wastewater engineers and planners, and perhaps,
- university professors with pertinent expertise.

Once the preferred technique is selected, additional field work should be part of the design effort. Such follow-up field work and design could uncover problems or inconsistencies not addressed when all the "applicable" techniques were evaluated. If problems and inconsistencies arise, some re-evaluation should be conducted.

Existing wastewater systems can be evaluated to select the preferred method for rehabilitation using a methodology quite similar to the methodology just presented for new systems. Figure 3-43 illustrates a useful methodology.

To begin consideration of rehabilitation techniques requires that a need for rehabilitation has been discovered. Existing on-site facilities, in particular, can cause groundwater or surface water contamination without being noticed. Periodic water quality monitoring activities usually cannot result in pinpointing sources of water pollution. Therefore, unless complaints are received from homeowners or water companies about contaminated wells, pollution can continue unnoticed for years, particularly from wastewater facilities placed in coarse-grained soils. County health departments are encouraged to perform field inspections and tests of on-site systems that have been utilized for more than 20 years.

The decision points in Figure 3-43 (in diamonds) progress from least costly to most costly methods of rehabilitation. Both the wastewater and

RECOMMENDED METHODOLOGY FOR SELECTING PREFERRED SYSTEM REHABILITATION TECHNIQUES

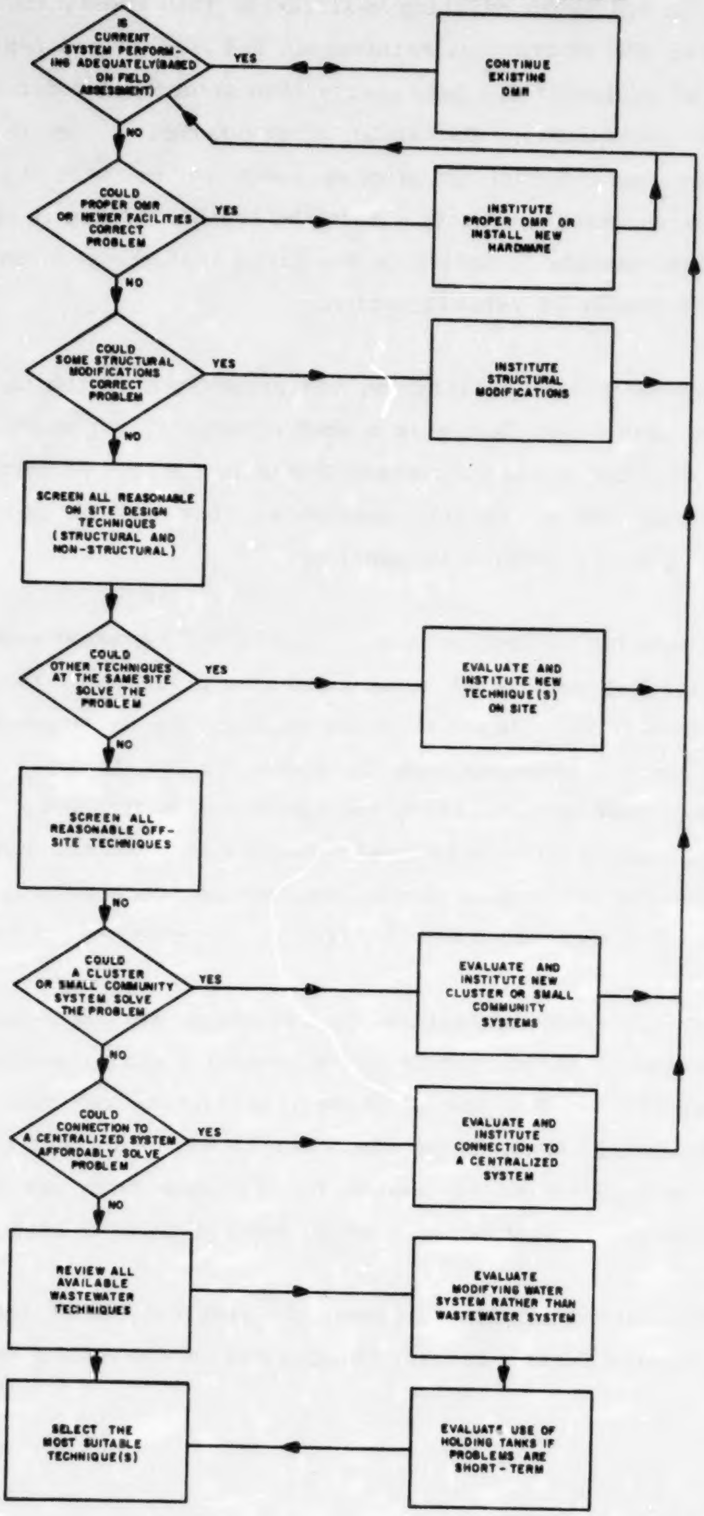

IS CURRENT SYSTEM PERFORMING ADEQUATELY (BASED ON FIELD ASSESSMENT)
YES
CONTINUE EXISTING OMR
NO
COULD PROPER OMR OR NEWER FACILITIES CORRECT PROBLEM
YES
INSTITUTE PROPER OMR OR INSTALL NEW HARDWARE
NO
COULD SOME STRUCTURAL MODIFICATIONS CORRECT PROBLEM
YES
INSTITUTE STRUCTURAL MODIFICATIONS
NO
SCREEN ALL REASONABLE ON SITE DESIGN TECHNIQUES (STRUCTURAL AND NON-STRUCTURAL)
COULD OTHER TECHNIQUES AT THE SAME SITE SOLVE THE PROBLEM
YES
EVALUATE AND INSTITUTE NEW TECHNIQUE(S) ON SITE
NO
SCREEN ALL REASONABLE OFF-SITE TECHNIQUES
NO
COULD A CLUSTER OR SMALL COMMUNITY SYSTEM SOLVE THE PROBLEM
YES
EVALUATE AND INSTITUTE NEW CLUSTER OR SMALL COMMUNITY SYSTEMS
NO
COULD CONNECTION TO A CENTRALIZED SYSTEM AFFORDABLY SOLVE PROBLEM
YES
EVALUATE AND INSTITUTE CONNECTION TO A CENTRALIZED SYSTEM
NO
REVIEW ALL AVAILABLE WASTEWATER TECHNIQUES
EVALUATE MODIFYING WATER SYSTEM RATHER THAN WASTEWATER SYSTEM
SELECT THE MOST SUITABLE TECHNIQUE(S)
EVALUATE USE OF HOLDING TANKS IF PROBLEMS ARE SHORT-TERM

FIGURE 3-43

water supply systems need to be evaluated for rehabilitation; it may be advantageous to modify an existing well rather than modify the wastewater system. Proper OMR (Operation, Maintenance and Repair) and replacement of small pieces of equipment are less costly than structural modifications and use of other techniques. Decisions about whether a certain form of rehabilitation can correct a problem need to be made by qualified sanitarians or sanitary engineers. Once the rehabilitation is implemented, a check needs to be made to verify in the field that the problem was indeed corrected as a result of rehabilitation.

If no methods for rehabilitating the wastewater system can solve the problem, then some other change is needed. Perhaps, for example, holding tanks can be utilized during a certain season or during wet periods. While such changes may not be totally desirable, they may be preferred over allowing the original problem to continue.

Many engineering techniques are available for managing wastewater and sludge generated at individual establishments, clusters of establishments and small communities. Most of these engineering techniques are technologically simple; problems usually arise due to improper design and installation or excessively infrequent operation, maintenance and repair. Many problems can develop with small wastewater systems, however, most remedies, like the techniques themselves, are not particularly difficult to implement. The techniques and problems are all examined in this chapter.

In selecting which techniques to implement at newly-developed locations, four basic factors should be evaluated: costs, impacts, operation and implementation. Any one of these four factors can rule out use of certain techniques. Those responsible for implementation typically consider costs and obstacles to implementation more than the other basic factors, although all four basic factors deserve careful attention.

In rehabilitating existing systems, the simplest, least costly options should be evaluated first. Careful rehabilitation can extend the life of a system in a cost-effective manner, even if rehabilitation costs seem high at the time.

The engineering techniques for designing, installing and maintaining small wastewater systems are neither financially burdensome nor technologically complex. Therefore, the key to successful use of small systems is adequate involvement and guidance from wastewater professionals whose objective is to provide safe, inexpensive and environmentally-sound wastewater systems.

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

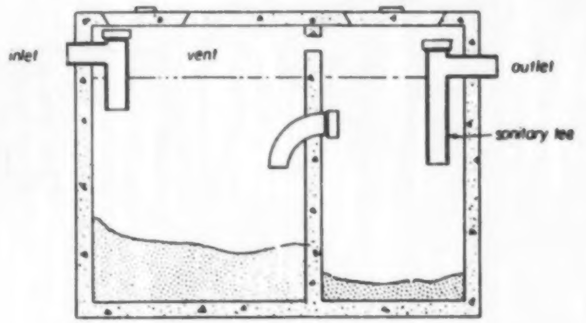
ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING TECHNIQUES

Figure 3-1

Septic Tank

DESCRIPTION SYSTEMS



Two Compartment Septic Tank

COMPONENTS

Concrete fiberglass or plastic circular or rectangular tank
Minimum detention time - 24 hours
Surface Area to depth ratio 2:1
Length to width ratio 3:1
Inlet and outlet protection with baffles or tees
Compartments 1 or 2; Two compartments with the first from 1/2 to 2/3 the total tank volume provide better treatment

EXAMPLES OF USAGE

Septic tanks ranging from 750 to 1,200 gallons in capacity are used in typical three-bedroom residential sewage treatment systems. Septic tanks connected in series can be used to treat higher waste volumes or to improve anaerobic digestion of small residential waste flows.

MANUFACTURER

Precast septic tanks up to 2,000 gallons in capacity are usually available directly from a local concrete products company. Large septic tanks are also built on-site by local contractors.

Plastic septic tanks - Hancor, Inc., Findley, OH

CONTACTS

Local concrete products companies, septic tank installors and fabricators.

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

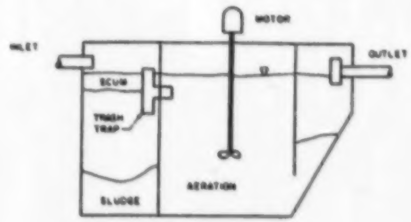
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-2

Aerobic Wastewater Treatment

DESCRIPTION OF SYSTEMS



Source: Boyle and Otis, 1979.

COMPONENTS

Tank (concrete, plastic or fiberglass) media
Aeration equipment - blower, diffusers
Clarifier
Controls and alarms
Trash trap or septic tank

EXAMPLES OF USAGE

Extended aeration batch and continuous flow
Fixed film - rotating biological contactor

These units are frequently used to treat flows from individual residences, clusters, school and mobile home parks. Effluent can be disinfected and discharged to lands or surface waters.

MANUFACTURER

Eastern Environmental Controls, Chestertown, MD
Nyadic Sciences, Inc., Clarks Summit, PA
Transamerican DeLaval, Inc., Covington, KY
Jet, Inc., Cleveland, OH
Owens Manufacturing and Specialty Co., Lafayette, LA
Norweco, Inc., Norwalk, OH
Cromaglass Corp., Williamsport, PA
Hycor Corp., Lake Bluff, IL
Bi-A-Robi Systems, Inc., Hamlin, PA
Manolf, Inc., Clearwater, FL
Economy Tank Co., St. Albans, WV

CONTACTS

Local Health Department Officials

Boyd County, KY

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

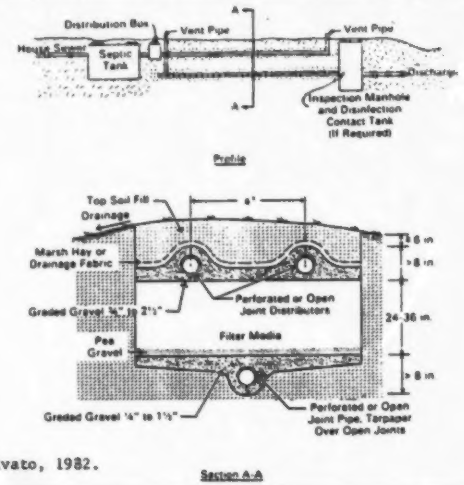
ALTERNATIVES
DEVELOPMENT REPORT

70<

FACT SHEET
ENGINEERING TECHNIQUES

Figure 3-3
Sand Filtration

DESCRIPTION OF SYSTEMS


A
Distribution Box
Vent Pipe
Vent Pipe
House Sewer
Septic Tank
Discharge
A
Inspection Manhole and Disinfection Contact Tank (If Required)
Profile
Top Soil Fill
Drainage
6'
Marsh Hay or Drainage Fabric
6 in
> 8 in
Graded Gravel ¾" to 2½"
Perforated or Open Joint Distributors
24-36 in.
Filter Media
Pea Gravel
> 8 in
Graded Gravel ¼" to 1½"
Perforated or Open Joint Pipe. Tarpaper Over Open Joints
Section A-A

Source: Salvato, 1982.

COMPONENTS

Pretreatment Unit

Sand filter constructed in an excavation lined with an impermeable liner

Underdrains and distribution piping consisted of perforated pipe surrounded in gravel envelope

Recirculation tank (optional) and flow splitter - recirculating sand filter

Intermittand sand filters - buried or free access

EXAMPLES OF USAGE

Sand filtration units provide excellent treatment of septic tank and small aerobic treatment units. High level treatment can be achieved from recirculating sand filters. These units treat flows typically ranging from 400 to 10,000 GPD. Units have been used for residential installation (new and repair), mobile home parks, recreation centers and small schools.

MANUFACTURER

Most sand filtration unit components, tanks, piping, sand, and gravel supplied locally. Recirculation tanks, if used, utilize sewage effluent pumps and controls supplied by previously referenced pump manufacturers

CONTACTS

A. R. Rubin, N.C. State University, Raleigh, NC

Sadieville, KY

Madison, NC

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

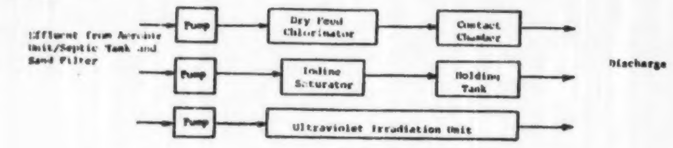
FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-4

Disinfection

DESCRIPTION OF SYSTEMS

FLOW DIAGRAM -


Effluent from Aerobic Unit/Septic Tank and Sand Filter
Pump
Dry Feed Chlorinator
Contact Chamber
Pump
Iodine Saturator
Holding Tank
Pump
Ultraviolet Irradiation Unit
Discharge

DISINFECTION METHODS

Source: U.S. EPA. 1979.

MANUFACTURER

Chlorinators

Capital Controls Co., Inc. (Colmar, PA)
Cheminler-Kenics, Inc. (Dayton, OH)
Chlorinators, Inc. (Jensen Beach, FL)
Fischer and Porter Co. (Warminster, PA)
Wallace and Tiernan Div., Pennwalt Corp. (Belleville, NJ)
Sanuril, Diamond Shamrock (Chardon, OH)
Various chemical companies supply chlorine or iodine.

Ultraviolet irradiation units

Capital Controls Co., Inc. (Colmar, PA)
Katadyn U.S.A., Inc. (Potomac, MD)
Portstar Div., Ultrasonics Research, Inc. (Jericho, NY)
Pure Water Systems, Inc. (Fairfield, NJ)

COMPONENTS

Dry feed chlorinators and contact chamber, or

Iodine saturator with pump and holding tank, or

Ultraviolet disinfection unit with controls, surge tank, and pump.

CONTACTS

Local and State Health Department Officials and equipment manufacturers

(See Appendix II B for a list of state health department contacts.)

EXAMPLES OF USAGE

Gravity fed tablet chlorination units are in widespread use due to simple construction, operation, and maintenance. Properly maintained dry-feed chlorinators, iodine saturators and ultraviolet light units have been shown to provide consistently high levels of disinfection for small waste flows. Ozone is another disinfectant, but its use at small treatment facilities in the United States is extremely limited.

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

74<

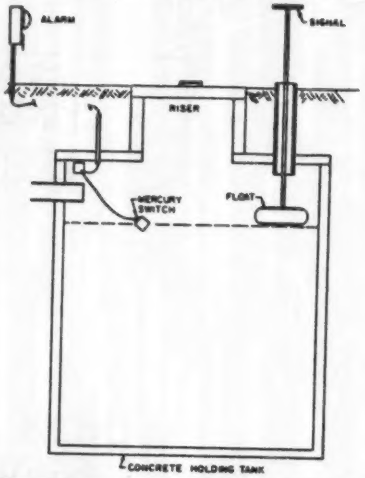
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-5

Holding Tank

DESCRIPTION OF SYSTEMS



Holding Tank - A watertight tank which receives and retains sewage for ultimate disposal at another location.

COMPONENTS

Minimum Tank Size - 1,000 gallons; approximately 1 week storage

Alarm System - Audio/visual such as an alarm mounted in a house and calibrated mechanical float device.

EXAMPLES OF USAGE

Sealed tanks which retain from typically 1,000 gallons or more from small flow residential dwellings such as seasonal/vacational units. Can be used in locations unsuitable for other sewage treatment and disposal units.

MANUFACTURER

Holding tank (plugged septic tank), alarm system fabricated or supplied locally

CONTACTS

County and State Health Department Officials and local contractors

(See Appendix II_B for a list of state contacts.)

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

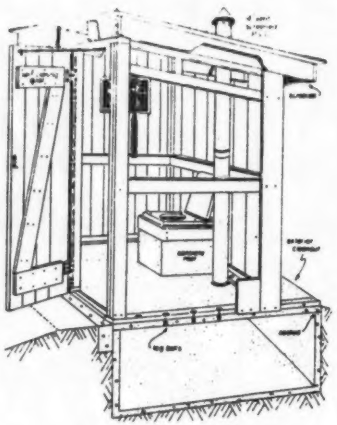
76<

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-6

Wastewater Containment
Privy

DESCRIPTION OF SYSTEMS



Privy - A tank designed to receive sewage where water under pressure is not utilized.

Source: Pennsylvania D.E.R., 1983.

COMPONENTS

Stable - weatherproof super structure; ventilated and insect proof

Concrete holding tank with cleanout

Grading to control surface water runoff

EXAMPLES OF USAGE

Sealed tanks or vaults capable of storing sanitary waste from small flow residential, seasonal or vacation type dwellings. Privies can be utilized in areas unsuitable for other sewage treatment and disposal techniques.

MANUFACTURER

Privies constructed from materials locally supplied

CONTACTS

County and State Health Department Officials

Installers/Contractors

(See Appendix II-B for a list of state health department contacts.)

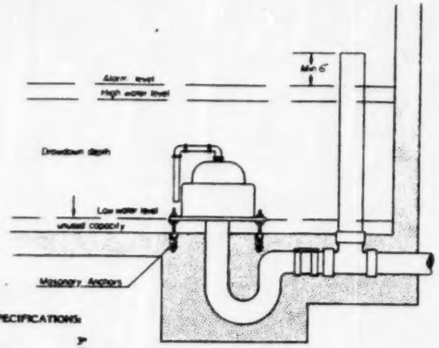
MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-7
Siphon

DESCRIPTION OF SYSTEMS



SIPHON SPECIFICATIONS:

Diameter	3"
Max. Discharge	96 gpm
Ave. Discharge	72 gpm
Min. Discharge	48 gpm
Low Water Level	3"
High Water Level	16"
Drawdown Depth	13"

COMPONENTS

Trap

Corrosion resistant bell or dome with vent piping

Discharge and overflow pipes

Tank design volume and reserve, concrete

Alarm, high water

EXAMPLES OF USAGE

Dosing of soil absorption systems on sloping terrain. Three feet elevation difference between siphon high water level and siphon discharge line. This is a wastewater distribution technique for beds, mounds, and trenches.

MANUFACTURER

Siphons are typically installed in smaller concrete tanks and even modified septic tanks by local contractors. Siphon components are in kit form and assembled in the tank.

Fluid Dynamics Company (Boulder, CO)

CONTACTS

Local contractors and sanitarians site and install siphons and sloping sites for wastewater distribution.

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

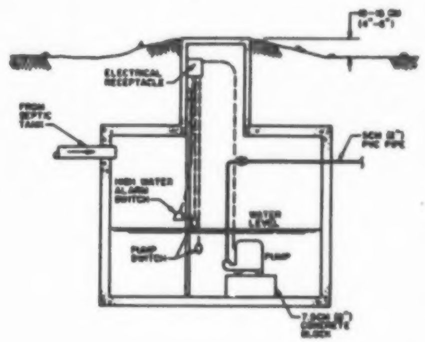
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-8

Pumping Tank

DESCRIPTION OF SYSTEMS


ELECTRICAL RECEPTACLE
FROM SEPTIC TANK
HIGH WATER ALARM SWITCH
WATER LEVEL
PUMP SWITCH
PUMP
PVC PIPE
CONCRETE BLOCK

COMPONENTS

Tank - sufficient capacity to accommodate design flow plus 1 to 1½ days reserve capacity

Submersible sewage effluent pump
Sealed mercury float switch
High water alarm system audio/visual
Sealed adjustable water level controls

EXAMPLES OF USAGE

Pressure distribution/dosing of wastewater effluents and lifting effluent to higher elevations where more suitable soil has been located for individual and cluster size sewage facilities.

MANUFACTURER

Pumping tank locally supplied

Pumps and Controls are supplied by numerous manufacturers and suppliers.

CONTACTS

Local Health Departments and Contractors
1984 Public Works Manual (200 S. Broad St., Ridgewood, NJ; Phone (201)445-5800)
Water and Wastewater Equipment Manufacturers Assn., Inc. (P.O. Box 17402, Dulles International Airport, Washington, DC 20041; Phone (703) 661-8011)

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

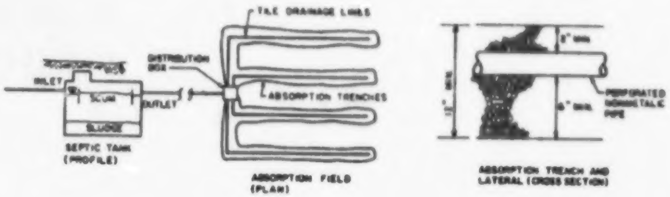
82<

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-9
Soil Absorption
Trenches

DESCRIPTION OF SYSTEMS

SOIL ABSORPTION TRENCHES


INLET
SCUM
SLUDGE
OUTLET
SEPTIC TANK (PROFILE)
DISTRIBUTION BOX
TILE DRAINAGE LINES
ABSORPTION TRENCHES
ABSORPTION FIELD (PLAN)
2" MIN.
6" MIN.
12" MIN.
PERFORATED HORIZONTAL PIPE
ABSORPTION TRENCH AND LATERAL (CROSS SECTION)

COMPONENTS

1,000-gallon 1 or 2-compartment septic tank with 2:1 or 3:1 length to width ratio and a 2:1 length to liquid depth ratio

Gravel lined trenches; 6" minimum depth

Laterals, perforated 3" or 4" diameter plastic pipe

Multi outlet distribution box

EXAMPLES OF USAGE

Single family residential lots with suitable space for construction of a primary and replacement system. Trench system can easily require 5,000 ft^2 of surface area for installation in addition to satisfying horizontal isolation distance requirements.

MANUFACTURER

Septic tank, distribution or drop boxes, gravel solid and perforated piping supplied locally

CONTACTS

County and State Health Department Officials

Local Installers/Contractors

(See Appendix II-B for a list of state contacts.)

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

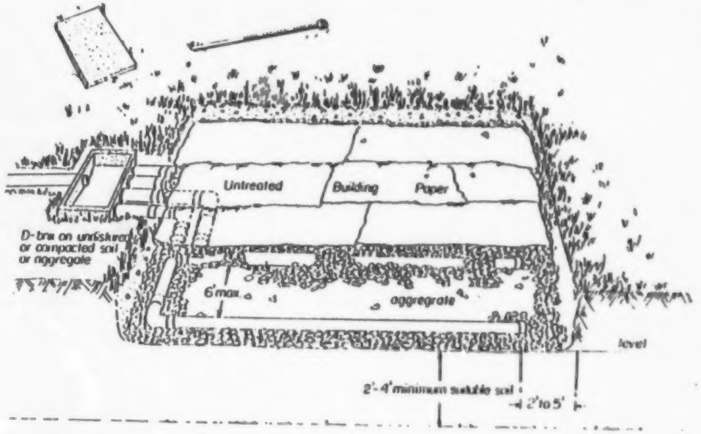
ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-10

Soil Adsorption
Seepage Bed

DESCRIPTION OF SYSTEMS


Untreated
Building
Paper
D-box on undisturbed or compacted soil or aggregate
6" max.
aggregate
level
2'-4' minimum suitable soil
2' to 5'

Source: Pennsylvania DER, 1983.

COMPONENTS

1,000 gallon 1 or 2 compartment septic tank, 2:1 or 3:1 length to width ratio, 2:1 length to liquid depth ratio

Excavated bed of 300 to 3,000 ft. of bottom area - lined with a minimum of 6" of gravel or crushed stone

Laterals, perforated 3 or 4" diameter
Distribution box for gravity distribution; pumps or siphon for pressure distribution

EXAMPLES OF USAGE

Single or multiple family dwellings or clusters having permeable soils and space limitations which preclude the use of trenches.

MANUFACTURER

Septic tank, distribution box (or closed loop) gravel, perforated pipe and other material supplied locally.

CONTACTS

County and Local Health Department Officials
Contractors

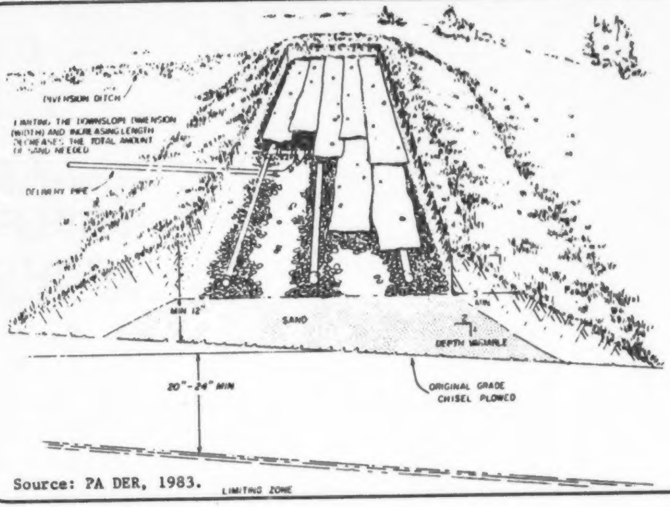
MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-11
Soil Absorption
Mound

DESCRIPTION OF SYSTEMS


DIVERSION DITCH
LIMITING THE DOWNSLOPE DIMENSION (WIDTH) AND INCREASING LENGTH DECREASES THE TOTAL AMOUNT OF SAND NEEDED
DELIVERY PIPE
MIN 12"
SAND
3 MIN
2
DEPTH VARIABLE
20"-24" MIN
ORIGINAL GRADE CHISEL PLOWED
LIMITING ZONE

Source: PA DER, 1983.

COMPONENTS

Pretreatment unit septic tank or aerobic unit
Filter Material - medium sands with 1 foot minimum depth
Crushed Stone - sand/sandy loam mixture
Crushed Stone Aggregate - 3/4 - 2½ inches, 9 inches deep
Distribution Network - small diameter (1-3 inches) pipe
Loamy Topsoil - 1½ feet deep at cap, 1 foot on sides

EXAMPLES OF USAGE

Allows for soil absorption on shallow (2 feet minimum) and slowly permeable soils. Long and narrow mounds with 3:1 downslopes highly recommended. Large waste flows may require multiple mounds.

MANUFACTURER

Constructed by local contractors.

CONTACTS

Madison County, NC Health Department,
Mike Bradley

Bobby L. Carlile, Raleigh, NC

James C. Converse, University of Wisconsin,
Madison, WI

Richard J. Otis, Rural Systems Engineering,
Madison, WI

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

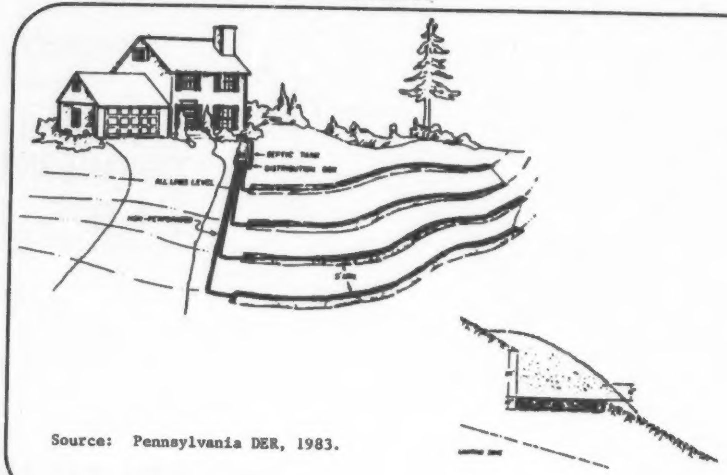
ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-12

Soil Absorption
Trenches Operated in Parallel

DESCRIPTION OF SYSTEMS



Source: Pennsylvania DER, 1983.

COMPONENTS

1,000-gallon, 1 or 2-compartment septic tank with 2:1 or 3:1 length to width ratio and a 2:1 length of liquid depth ratio

Gravel lined trenches; 6" minimum depth

Laterals, perforated 3" or 4" diameter plastic pipe

Multi outlet distribution box

EXAMPLES OF USAGE

Single family residential lots with suitable space for construction of a primary and replacement system. Trench system can easily require 5,000 ft^2 of surface area for installation in addition to satisfying horizontal isolation distance requirements.

MANUFACTURER

Septic tank, distribution or drop boxes, gravel and perforated pipe supplied locally

CONTACTS

County and State Health Department Officials

Local Installers

(See Appendix II-B for a list of state contacts.)

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

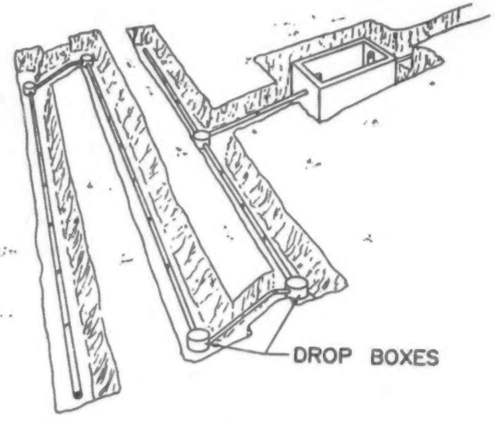
ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING TECHNIQUES

Figure 3-13

Soil Absorption
Distribution of Effluent
With Drop Boxes

DESCRIPTION OF SYSTEMS



Source: Kentucky Cabinet for Human Resources, 1982.

COMPONENTS

Pretreatment unit

Drop boxes

Trenches - see separate Fact Sheet

EXAMPLES OF USAGE

Residential and other small flow applications on sloping sites. Wastewater can flow by gravity or be lifted by pumps to higher elevation absorption areas.

MANUFACTURER

Pretreatment units, drop boxes, distribution piping, and gravel supplied locally.

CONTACTS

State and County Health Department Officials

(See Appendix II-B for a list of state contacts.)

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

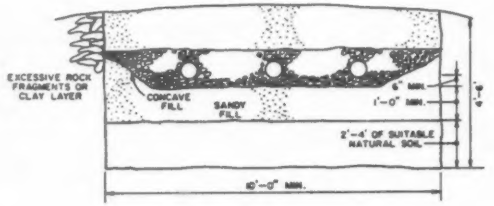
ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING TECHNIQUES

Figure 3-14

Soil Absorption
Subsurface Sand Filter
Without Under Drains

DESCRIPTION OF SYSTEMS


EXCESSIVE ROCK FRAGMENTS OR CLAY LAYER
CONCAVE FILL
SANDY FILL
6" MIN.
1'-0" MIN.
2'-4' OF SUITABLE NATURAL SOIL
6'-0"
10'-0" MIN.

MANUFACTURER

Treatment unit, distribution piping, sand and gravel supplied locally.

COMPONENTS

Pretreatment, e.g., septic tank

Minimum of 1 foot of clean medium sand placed in the zone which is either slowly or excessively permeable.

Distribution network - gravity or pressure

CONTACTS

Local Health Department Officials

These systems are widely used within the study area

EXAMPLES OF USAGE

Utilize in areas with soils that are excessively permeable due to high volume coarse fragment content. This system can also be used where a slowly permeable soil horizon exists at depths of one to four feet.

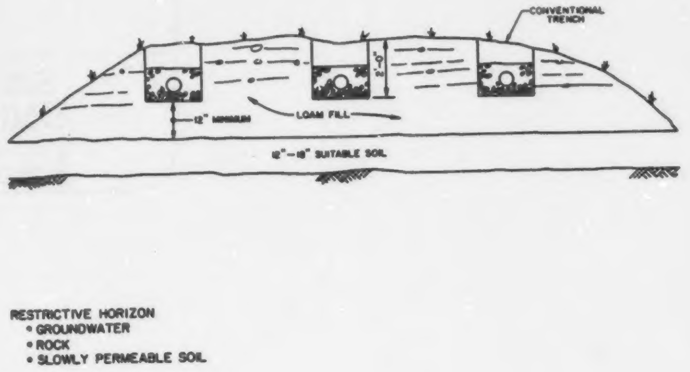
MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING TECHNIQUES

Figure 3-15
Soil Absorption
Filled/Built Up Area

DESCRIPTION OF SYSTEMS


CONVENTIONAL TRENCH
2'-3'
12" MINIMUM
LOAM FILL
12"-18" SUITABLE SOIL
RESTRICTIVE HORIZON
• GROUNDWATER
• ROCK
• SLOWLY PERMEABLE SOIL

MANUFACTURER

Septic tank or aerobic treatment unit, distribution piping and fill material locally supplied.

COMPONENTS

Imported loamy, sandy loam soil in place long enough so that natural permeability has been restored

Perforated laterals in stone/gravel aggregate

Supply distribution system - gravity or pressure

Pretreatment unit (septic or aerobic unit)

CONTACTS

Madison County, NC Health Department, Mr. Mike Bradley

EXAMPLES OF USAGE

Can be utilized in areas where there is insufficient natural soil to provide sufficient wastewater rennovation or areas where shallow depths to restrictive features like clay pans or fracturered rock exists.

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

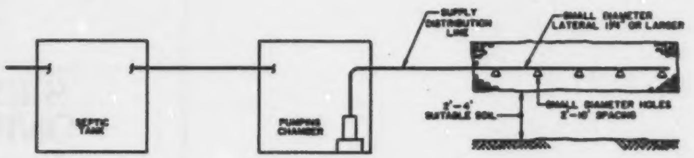
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-16

Soil Absorption
Low-Pressure Pipe

DESCRIPTION OF SYSTEMS


SEPTIC TANK
PUMPING CHAMBER
SUPPLY DISTRIBUTION LINE
SMALL DIAMETER LATERAL 1½" OR LARGER
2'-4' SUITABLE SOIL
SMALL DIAMETER HOLES 2'-10' SPACING

COMPONENTS

Two-Compartment septic tank
Pumping chamber (tank) with sewage effluent pump or siphon
Supply distribution pipe
Small diameter lateral, 1¼" on larger with evenly spaced small diameter holes typically 3/16" to 3/8", located in shallow gravel lined trenches

EXAMPLES OF USAGE

Residential and other small flow applications where suitable soil and site conditions exist for soil absorption. System provide excellent wastewater distribution and utilize upper more permeable soil horizons for absorption.

MANUFACTURER

Septic tank, pumping tank, gravel and piping supplied locally. Pump or siphons with alarms and controls supplied by many manufacturers, see Fact Sheet (S.T.E.P.)

CONTACTS

Craig Cogger, University of N.C., Raleigh, NC

Bobby Carlile, Raleigh, NC

Dennis Osborne, University of N.C., Raleigh, NC

Larry Robinson, Williamson County Health Department, Franklin, TN

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

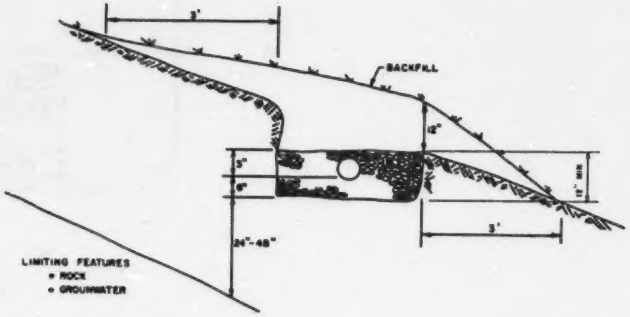
98

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-17

Soil Absorption
Shallow Trench(es)

DESCRIPTION OF SYSTEMS



Source: Pennsylvania DER, 1983 (with modifications).

MANUFACTURER

Pretreatment unit, e.g. septic tank, distribution network, piping, gravel, and fill material supplied locally

COMPONENTS

Pretreatment
Wastewater Distribution Network
    Gravity - drop box(s)
        distribution box
    Pressure - pump or siphon
Laterals 1¼ to 4 inch diameter, perforated pipe is located in 6 inches of crushed stone or gravel
Loamy backfill capable of supporting vegetative growth (grass)

CONTACTS

County and State Health Department Officials

Installers/Contractors

(See Appendix II-B for a list of state contacts.)

EXAMPLES

Hillside trench installations on sloping sites for small individual or cluster type absorption areas.

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

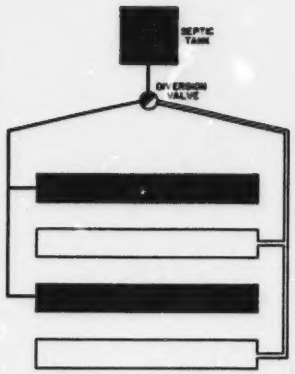
100<

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-18

Soil Absorption
Alternating Trench System
With Diversion Valve

DESCRIPTION OF SYSTEMS



Source: U.S. EPA, 1980a.

COMPONENTS

Diversion valve

Watertight riser and access cap

Absorption areas - 50 to 100% of required land area

EXAMPLES OF USAGE

Residential installations, allows resting of 50 - 100% of required absorption area.

MANUFACTURER

Bull Run Valve, Mannassas, VA

Some diversion devices are made from commercially available materials and fabricated at the job site.

CONTACTS

Used extensively in eastern Tennessee by local Health Department Officials

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

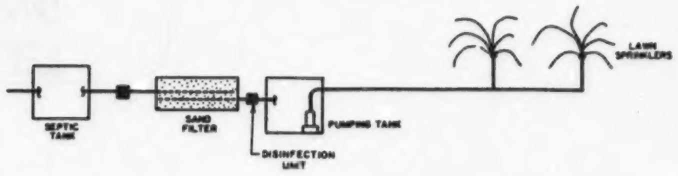
ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING TECHNIQUES

Figure 3-19

Septic Tank-Sand Filtration-Irrigation

DESCRIPTION OF SYSTEMS



COMPONENTS

Two-Compartment septic tank
Distribution - dosing pump or siphon
Sand filter with granular material
    Under drains
    Small diameter distribution network in gravel aggregate
Disinfection/pumping tank - store 1½ days of wastewater
Submersible sewage effluent pump with controls and high water alarm
Supply distribution network with non-clogging (pop up) sprinkler
fixed sprinklers; Disinfection - stock feed chlorinator

EXAMPLES OF USAGE

Treatment and disposal of residential and other small flow sand filter effluents by turf irrigation is increasing. This method is being used in regions with stream discharge limitations and concerns about groundwater recharge along the East Coast.

MANUFACTURER

Septic tank, sand filtration unit, pumping tank, controls and supply distribution system supplied locally

Disinfection -

Sprinklers - Toro Company (Minneapolis, MN)
Safe-T-Lawn, Inc., (Hialeah, FL)

Turf Sprinklers - Toro Company (Minneapolis, MN)
Rain Bird (Glendora, CA)
Hardie Irrigation (Laguna Niguel, CA)

Disinfection - See separate Fact Sheet.

CONTACTS

N.C. State AG Extension Services, Robert Rubin

Turf Irrigation Equipment Companies

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

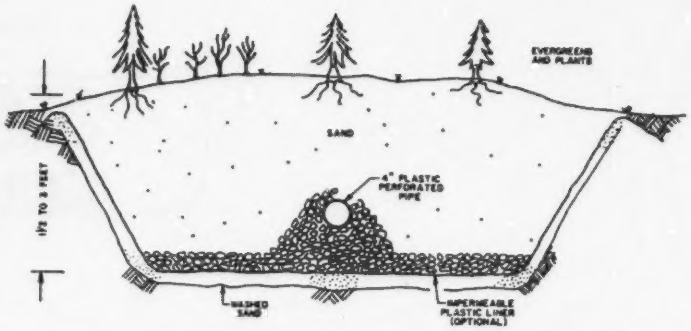
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-20

Evapotranspiration Bed

DESCRIPTION OF SYSTEMS


EVERGREENS AND PLANTS
SAND
4" PLASTIC PERFORATED PIPE
1½ TO 3 FEET
WASHED SAND
IMPERMEABLE PLASTIC LINER (OPTIONAL)

Source: U.S. EPA, 1977a and 1980c.

COMPONENTS

Sand Bed
Stone/Gravel Aggregate
Impermeable Plastic Liner
Distribution Piping
Vegetation with high (water) consumptive use (e.g., grasses, shrubs, hardwood trees, and conifers)

EXAMPLES OF USAGE

Treating and disposal of small volume waste flows in the Appalachian Mountain region. Process by itself not capable of treating large waste flows due to high rainfall.

MANUFACTURER

Treatment units (septic tank, aerobic), sand filter material, supply distribution components, plastic liner supplied locally. Vegetation stock or seed obtained from local nursery.

CONTACTS

H

Madison County, NC Health Department, Mike Bradley

Tims Ford Lake, TN TVA, Mr. Winford H. Long Sequoyah Nuclear Plant

Richard Weigand, Wood County, Health Department, Parkersburg, WV

Peter Henning, Bowling Green State University, Huron, OH

Knox County, TN Health Department, Mr. David McKinney

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

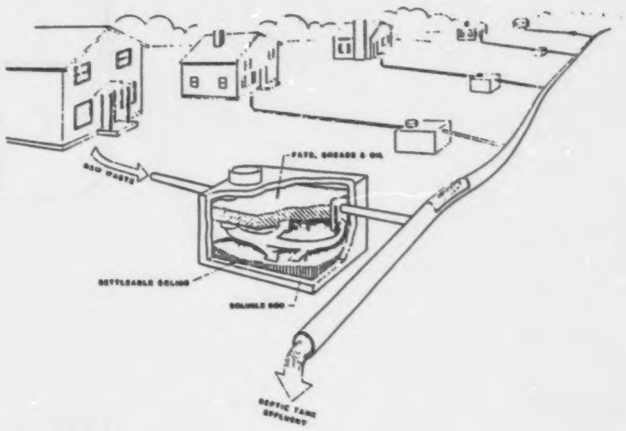
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-22

Small-Diameter
Gravity Sewers

DESCRIPTION OF SYSTEMS


FATS, GREASE & OIL
RAW WASTE
SETTLEABLE SOLIDS
SOLUBLE BOD
SEPTIC TANK EFFLUENT

COMPONENTS

Pretreatment - septic tank to prevent grease, grit, and other solids from entering the collector mains

Collector Mains, 4" to 8" diameter Plastic or larger

Cleanouts, 300' to 50C' spacing and at special junctions

Manholes, major junctions, deep intersections

EXAMPLES OF USAGE

Small diameter gravity sewers are being used to collect and transport septic tank effluent from homes in sparsely developed areas with significant savings in construction costs.

MANUFACTURER

Septic tanks, cleanouts, manholes, and small diameter plastic pipes can be supplied locally.

CONTACTS

Fountain Run, KY

Sadieville, KY

Lafayette, TN

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

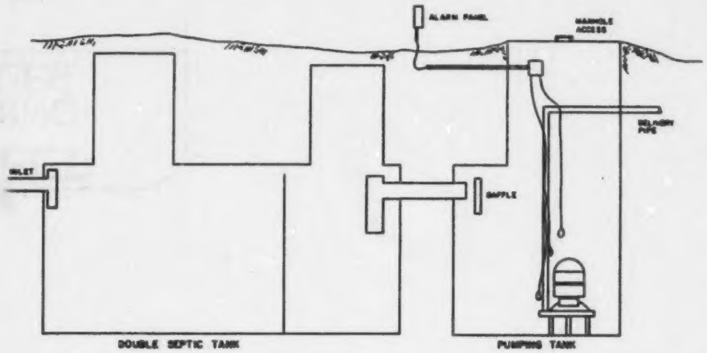
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-23

Septic Tank Effluent Pump
Pressure System

DESCRIPTION OF SYSTEMS



MANUFACTURER

Septic Tanks and pumping tanks are supplied locally. Effluent pumps can be obtained from local plumbing/building suppliers. Pumps can be chosen from more than a dozen manufacturers.

COMPONENTS

Two-compartment Septic Tank
Pumping tank with reserve capacity (1½ days detention time)
Submersible sewage effluent pump
  Level controls - floating mercury or mechanical
  High water alarm with audible and visual signals

CONTACTS

Fountain Run, KY

Inez, KY

Shadyville, KY

Berry, KY

Shallotte, NC

Cresswell, NC

Canterfield Development - Chapel Hill, NC

EXAMPLES OF USAGE

Septic tank effluent pumps can be utilized to convey partially treated wastewater directly from septic tanks or separate pumping chambers via small diameter lines 1½" and larger to pressurized or gravity sewers, to a soil absorption system or other final treatment and disposal facility.

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

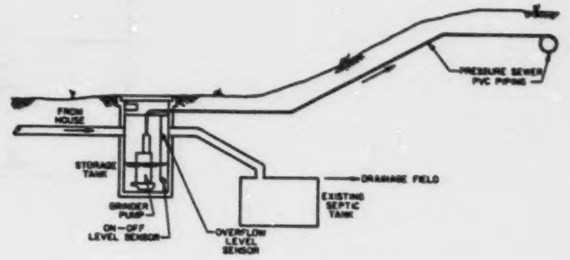
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-24

Grinder Pumps

DESCRIPTION OF SYSTEMS


FROM HOUSE
STORAGE TANK
GRINDER PUMP
ON-OFF LEVEL SENSOR
OVERFLOW LEVEL SENSOR
EXISTING SEPTIC TANK
DRAINAGE FIELD
PRESSURE SEWER PVC PIPING

Source: U.S. EPA, 1977.

COMPONENTS

Storage tank - design flow plus reserve capacity, cone-fiberglass

Grinder pump with level controls; floating or small diameter discharge line with check valve

EXAMPLES OF USAGE

Grinder pumps can be used to serve fron one to four residential dwellings and lift wastewater to rather high elevation with simplistic means. Small diameter service lines typically discharge to two to twelve inch. Pressure of gravity mains leading to the final treatment facility.

MANUFACTURER

Tanks typically made by pump manufacturer and sold as a package along with high level alarms and controls.

ABS Pumps Inc. (Meriden, CT)
Environment/One Corp. (Schenectady, NY)

Goulds Pumps Inc. (Seneca Falls, NY)
Peabody Barnes Inc. (Mansfield, OH)
Gorman - Rupp Co. (Mansfield, OH)

CONTACTS

Chickasaw Point Development, Lake Hartwell, SC

Sacremento, KY

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

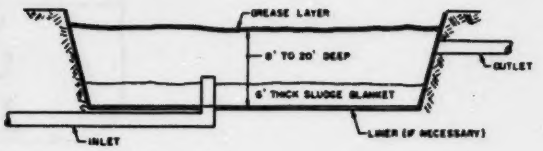
112

FACT SHEET
ENGINEERING TECHNIQUES

Figure 3-25

Lagoon

DESCRIPTION OF SYSTEMS



Source: U.S. EPA, 1980c.

COMPONENTS

Types of Lagoons:	Depth (ft)
High-rate aerobic	1 to 1.5
Facultative	3 to 8
Anaerobic	Variable
Maturation	3 to 8
Aerated	Variable

Pretreatment Unit

Excavated or built up area for wastewater storage, lined with clay, asphaltic coating, bentonite, plastic or rubber membrane, or other materials.

EXAMPLES OF USAGE

Lagoons have been providing low cost treatment of sewage from large and small communities. Treatment performance has been increased by constructing lagoons in series to lengthen detention times. Lagoons have been used extensively in the southeast region of the U.S.

MANUFACTURER

Pretreatment Units
- Septic tank - see separate Fact Sheet
- Aeration - see separate Fact Sheet
- Sand filtration - see separate Fact Sheet
- Package Plant - see separate Fact Sheet

Pond excavation, liner materials and piping supplied locally.

CONTACTS

Individual State 201 Construction Grants Program Offices

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

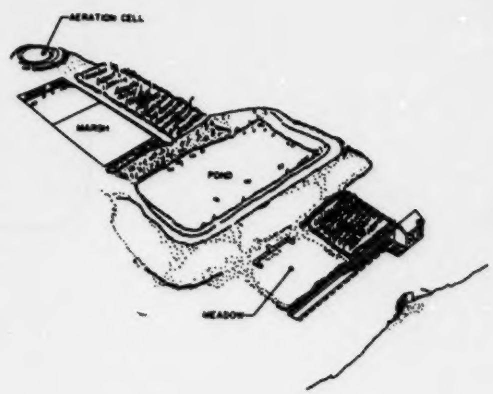
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-26

Marsh-Pond-Meadow

DESCRIPTION OF SYSTEMS



Source: Pennsylvania DER, 1983.

COMPONENTS

Comminutor
Aeration cell with aerator
Marsh with hydric vegetation (e.g., cattails, bullrush)
Pond - aerobic
Meadow - water-tolerant vegetation
Disinfection
Distribution piping

EXAMPLES OF USAGE

Treatment and disposal of flows typically less than 50,000 GPD. Iselin, PA residential rural development; Neshaminy Falls, PA, mobile home park

MANUFACTURER

Components for distribution system, marsh, pond, and meadow locally supplied.

Comminutors - See fact sheet for preliminary treatment
Mechanical Aerators (mid-Atlantic and Southeastern U.S.)
Barebo, Inc./Otterbine (Emmaus, PA)
Clow Corp., Waste Treatment Div. (Florence, KY)
Environmental Protection Specialists, Inc. (Atlanta, GA)
FMC Corp., Material Handling System Div. (Colmar, PA)
Infilco Degremont, Inc. (Richmond, VA)
Parkson Corp. (Ft. Lauderdale, FL)
Passavant Corp. (Birmingham, AL)
Schramm, Inc. (West Chester, PA)
Sydnor Hydrodynamics, Inc. (Richmond, VA)
Washington Aluminum Co. (Baltimore, MD)

Disinfection - See fact sheet for disinfection

CONTACTS

Foster D. Diodato, PA Department of Environmental Resources, Harrisburg, PA 17101

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

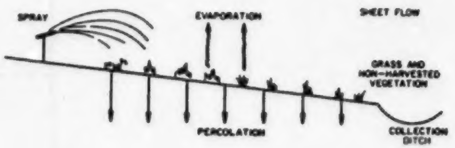
ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-27

Irrigation

DESCRIPTION OF SYSTEMS



Source: U.S. EPA, 1979.

COMPONENTS

- Pre-Treatment Unit
  - Primary - acceptable for isolated locations
  - Biological, e.g. lagoons - acceptable for controlled agricultural irrigation
  - Disinfection
  - Storage tank or pond
- Suitable area with buffer zone
- Distribution system, sprinkler or surface piping, pump

EXAMPLES OF USAGE

Septic tank - sand filtration - irrigation, cropland, woodland

Aerobic treatment - irrigation, cropland, woodland

MANUFACTURER

Cornell Industries (Williamstown, NY)
Long Mfg. N.C. Co. (Tarboro, NC)
McDowell Manufacturing Co. (DuBois, PA)
Toro Company (Minneapolis, MN)
James Hardie Irrigation (Laguna Niguel, CA)
Rain Bird (Glendora, CA)
Rainbow Mfg. Company (Fitzgerald, GA)
Valmont Industries, Inc. (Valley, NE)

CONTACTS

Rubin, A. R., N.C. State University, Raleigh
Overcash, M., N.C. State University, Raleigh

Florence Alabama, Paul M. Giordana TVA
Unicoi, GA
Chickasaw Point Development, Lake Hartwell, SC
White House, TN
Charlotte, TN
Gibson, TN
Helen, GA
Crofton, KY
Easley, SC
Cumberland Mountain State Park, TN

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

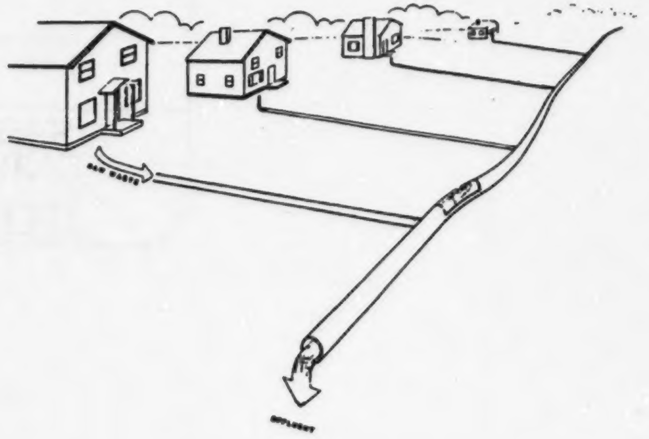
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-28

Conventional Gravity Sewers
(with or without lift station(s))

DESCRIPTION OF SYSTEMS



COMPONENTS

Minimum size: 6-inch diameter for all laterals in collection system
Minimum Slope: dependent upon size and wastewater flow characteristics
Concrete manholes every 300 to 500 ft or at changes in slope or direction
Pipe materials: asbestos-cement, clay, concrete, cast iron, and plastic

EXAMPLES OF USAGE

Gravity sewers are the oldest and most common wastewater collection system in existence. In rural areas, gravity sewers usually have the highest capital costs of any type of wastewater collection system due to sparse populations, the need for lift stations and potentially deep rack excavations.

MANUFACTURER

__Plastic Pipe__

Crestline Plastic Pipe Co.
Vassallo, Inc.
Century Fiberglass Co.
North Star Co.
Charlotte Pipe and Foundary Co.
Certainteed Corp.

__Cast Iron Pipe__

American Cast Iron Co.
Atlantic States Cast Iron Pipe Co.
Griffin Pipe Prod. Co.
McWane Cast Iron Pipe Co.
U.S. Pipe and Foundry Co.

__Asbestos Cement Pipe__

Capco Pipe Co., Inc.
Certainteed Corp.

__Concrete Pipe__

United Concrete Pipe
GHA Lock Joint
Price Bros. Company
U.S. Pipe and Foundry Co.

__Clay Pipe__

Building Prod. Co.
Dickey Company
Kaul Clay Company
Larsen Clay Pipe Co.
Logan Clay Pipe Co.

H

CONTACTS

Local contractors, engineers, and pipe manufacturers.

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

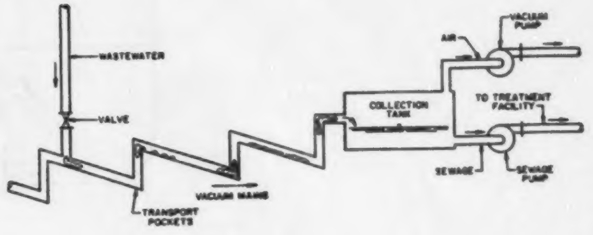
120<

FACT SHEET
ENGINEERING TECHNIQUES

Figure 3-29

Vacuum Sewers

DESCRIPTION OF SYSTEMS


WASTEWATER
VALVE
TRANSPORT POCKETS
VACUUM MAINS
COLLECTION TANK
AIR
VACUUM PUMP
TO TREATMENT FACILITY
SEWAGE
SEWAGE PUMP

Source: U.S. EPA, 1977a.

COMPONENTS

Collection/vacuum tank with pump

Vacuum/atmospheric pressure interface valve

Vacuum sewer lines

EXAMPLES OF USAGE

Vacuum sewers have been successfully used in areas that have flat to gently sloping terrain with shallow and somewhat poorly drained soils. Where terrain features favor gravity systems, vacuum sewers are seldom a cost-effective method of wastewater collection.

MANUFACTURER

Airvac, Inc. (Rochester, IN)

Envirovac, Inc. (Rockford, IL)

CONTACTS

Westmoreland, TN
Eastpoint, FL
Maryland Marine Utilities, Ocean Pines, MD
Queen Anne's County, MD (Kent Morrows/
Stevensville/Grosonville Area)
Centertown, KY
Broadcreek P.S.D. and Forest Beach P.S.D,
Hilton Head, SC

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

FACT SHEET

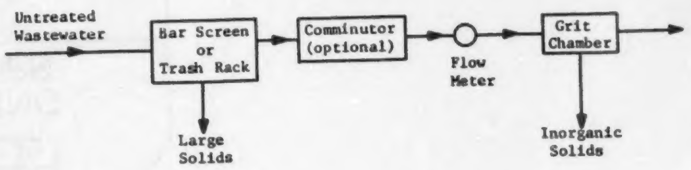
ENGINEERING TECHNIQUES

Figure 3-30

Preliminary Wastewater Treatment

DESCRIPTION OF SYSTEMS

Preliminary Treatment


Untreated Wastewater
Bar Screen or Trash Rack
Comminutor (optional)
Flow Meter
Grit Chamber
Large Solids
Inorganic Solids

Purpose - To remove or shred large objects and grit which could damage subsequent treatment units and pumps.

Notes - Wedge-wire screens could also be utilized to remove large organic solids.

COMPONENTS

Screens
Grinder
Comminutor (usually part of influent piping for small systems)
Flow meter

EXAMPLES OF USAGE

Preliminary treatment is utilized at nearly all municipal wastewater treatment plants and at many wastewater pumping stations.

MANUFACTURER

Screens and grit removal

FMC Corp. (Colmar, PA)
Dorr-Oliver, Inc. (Stamford, CT)
Envirex, Inc. (Waukesha, WI)

Comminution (small systems)

Dorr-Oliver
Euramca Ecosystems, Inc. (Addison, IL)
Franklin Miller, Inc. (West Orange, NJ)
Dresser Industries, Jeffrey Mfg. Div.
  (Woodruff, SC)

Various types of grit chambers have been manufactured; most types are for large municipal treatment plants.

CONTACTS

Any sanitary engineer in the government or private sector.

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

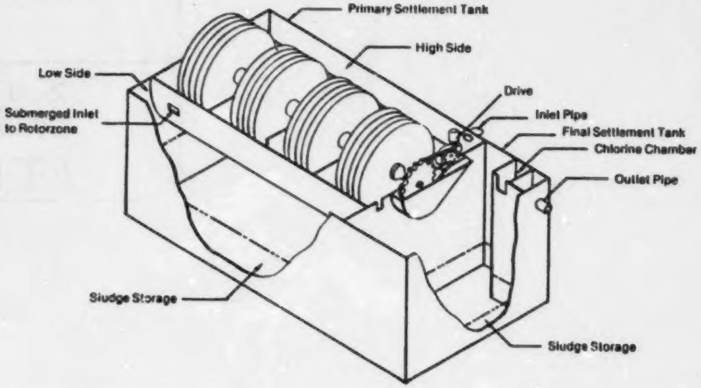
ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING
TECHNIQUES

Figure 3-31

Rotating Biological Contactor (RBC)

DESCRIPTION OF SYSTEMS


Primary Settlement Tank
High Side
Low Side
Submerged Inlet to Rotorzone
Drive
Inlet Pipe
Final Settlement Tank
Chlorine Chamber
Outlet Pipe
Sludge Storage
Sludge Storage

Source: Kentucky Cabinet for Human Resources, 1982.

COMPONENTS

Tank, steel or concrete

Circular Biological Contactors

Drive motor for circular disks

EXAMPLES OF USAGE

Treats flows from 400 to 100,000 GPD. 90-95% reduction in suspended solids and BOD. Lowest operating costs among mechanical aerobic units. Capable of treating residential, cluster, and small community waste flows.

MANUFACTURER

Purestream Waste Treatment Division of Transamerica Delavel, Covington, KY

CMS Rotordisk, Inc., Mississauga, Ontario

CONTACTS

Lake City, SC
Hardinsburg, KY

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

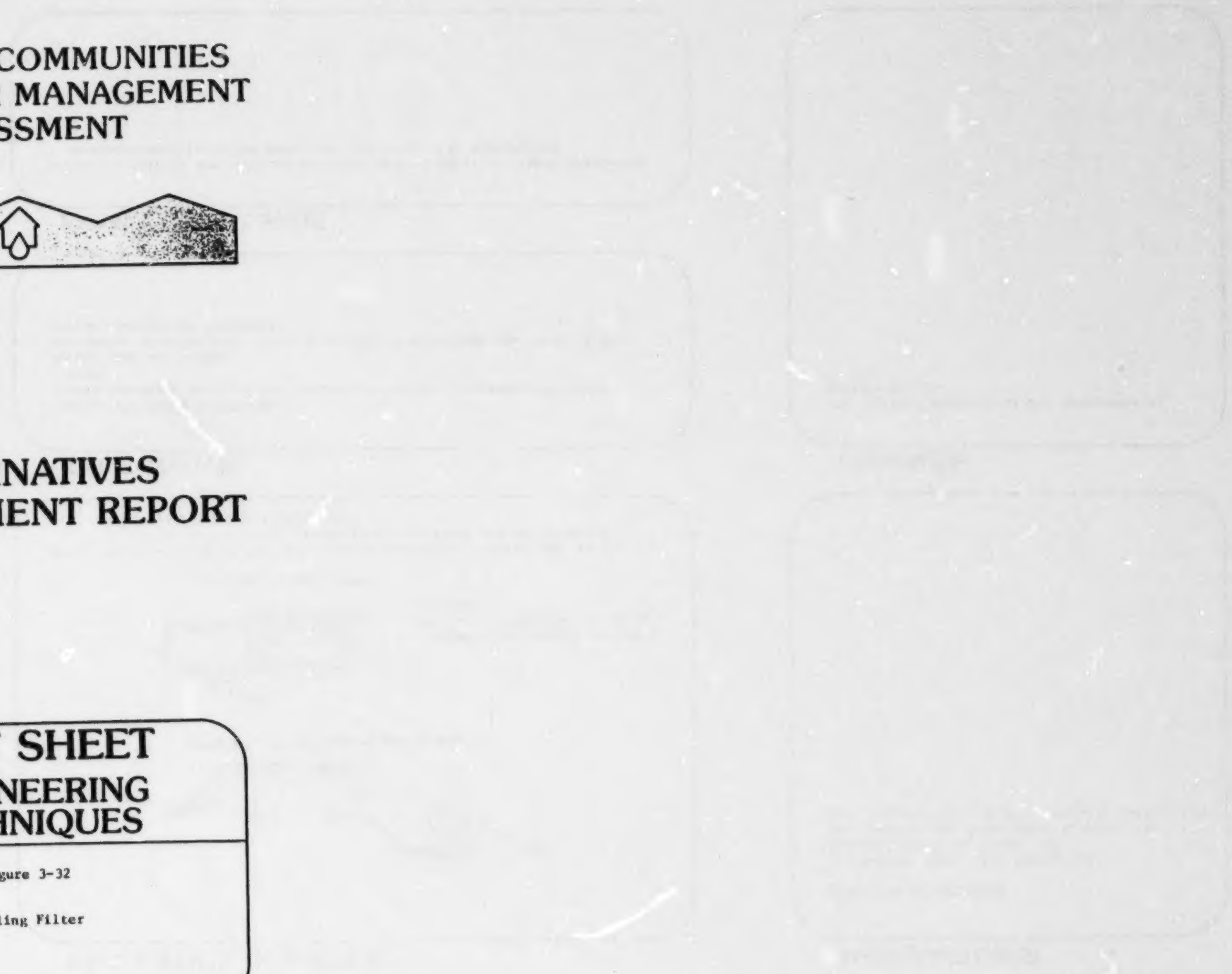
ALTERNATIVES DEVELOPMENT REPORT

FACT SHEET

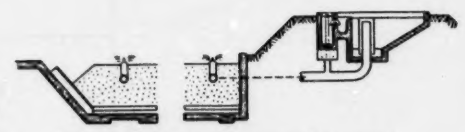
ENGINEERING TECHNIQUES

Figure 3-32

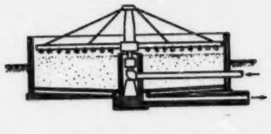
Trickling Filter



DESCRIPTION OF SYSTEMS



trickling filter with fixed nozzles and automatic dosing tank



trickling filter with rotary distributor

Purpose - To provide secondary wastewater treatment prior to disposal.

Note - Various types of filter media and various wastewater application rates can be utilized. Preliminary treatment and settling are preferred prior to filter use.

COMPONENTS

Piping, including underdrains
Rockor synthetic media within enclosed structure, sometimes including a cover
Dosing tank and siphon
Wastewater distributors: nozzels or disc distributors for small filters
Forced ventilation (optional)

EXAMPLES OF USAGE

Trickling filters are commonly utilized at both small and large wastewater treatment facilities for municipal and industrial wastewaters.

MANUFACTURER

Synthetic filter media

The Munters Corp. (Ft. Myers, FL)
General Filter Co. (Ames, IA)
American Surfpac Corp. (West Chester, PA)
B.F. Goodrich Co., Enviro. Products (Akron, OH)

CONTACTS

Any sanitary engineer in the government or private sector.

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

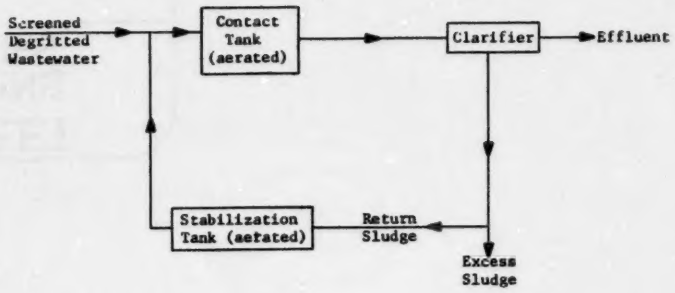
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-33

Contact Stabilization

DESCRIPTION OF SYSTEMS



Note: The process requires smaller tank volume and shock loads are handled better than in the conventional activated sludge technique. Flow equalization is recommended particularly for plants smaller than 50,000 gallons per day if effluent is to be discharged to a surface water body. Close operator attention is required.

COMPONENTS

Contact tank with 30 to 60 minute wastewater detention time
Clarifier
Stabilization tank with sludge detention time of 2 to 6 hours
Air diffusers and compressors
The tanks and clarifier often can be purchased as one package plant unit.

EXAMPLES OF USAGE

This technique is commonly utilized as package wastewater treatment plants throughout the country. An engineer at the state environmental protection agency can provide specific examples within each state.

MANUFACTURER

Air Diffusers

Chemineer - Kenics, Inc. (Dayton, OH)

Compressors for Aerating Wastewater

BVS, Inc. (Honey Brook, PA)
Becker Pumps Corp. (Akron, OH)
Cooper Energy Services (Mt. Vernon, OH)
FMC Corp. (Colmar, PA)
Fuller Company (Bethlehem, PA)
Ingersoll-Rand (Mocksville, NC)
Joy Mfg. Co. (Montgomeryville, PA)
Schramm, Inc. (West Chester, PA)
Sulzer Bros., Inc. (New York, NY)

Numerous manufacturers of tanks, clarifiers, and pumps are available.

CONTACTS

Water and Wastewater Equipment Manufacturers Association, Inc. (P.O. Box 17402, Dulles International Airport, Washington, DC 20041 (phone - 703-661-8011)) or your state environmental protection agency.

(See Appendix II-B for a list of state agency contacts.)

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

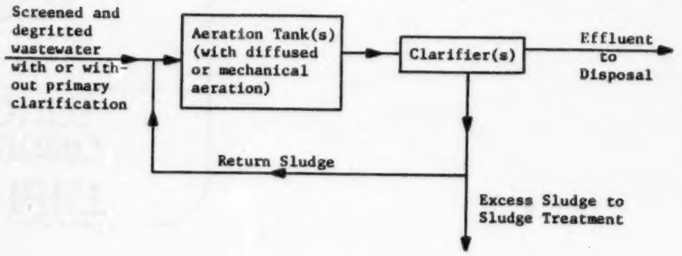
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-34

Extended Aeration/Activated
Sludge Wastewater Treatment

DESCRIPTION OF SYSTEMS


Screened and degritted wastewater with or without primary clarification
Aeration Tank(s) (with diffused or mechanical aeration)
Clarifier(s)
Effluent to Disposal
Return Sludge
Excess Sludge to Sludge Treatment

Purpose - to oxidize organic matter and then to separate the oxidized material away from the wastewater to the sludge. With additional detention time in the aeration tank(s), ammonia-nitrogen can be oxidized to nitrate-nitrogen further reducing the oxygen demanded by the wastewater.

COMPONENTS

Aeration tank(s) with diffuser(s) and compressor or with agitator(s) (see Figure 3-2), clarifier(s), valves and flow meter(s) in addition to pipeline and pumps (as needed). Various types of aerators are available. Inserts to clarifiers can be utilized to increase solids settling.

EXAMPLES OF USAGE

These processes are commonly utilized at municipal and package treatment plants to provide secondary wastewater treatment. The wastewater may or may not have undergone primary treatment (clarification) prior to reaching the aeration tank.

MANUFACTURER

Extended aeration units can be provided as part of a package plant. See figure 3-2 for manufacturers of aeration tanks.

Clarifiers

Clow Corp., Waste Treatment Div. (Florence, KY)
Davco Div., Davis Water and Waste Industries, Inc. (Thomasville, GA)
Dresser Industries, Inc., Jeffrey Mfg. Div. (Woodruff, SC)
Enviro. Elements Corp. (Baltimore, MD)
FMC Corp., Material Handling Sys. Div. (Colmar, PA)
Hendrick Fluid Systems Div. (Owensboro, KY)
Infilco Degremont, Inc. (Richmond, VA)
Kennecott Corp. (Knoxville, TN)
The F.B. Leopold Co. (Zelienople, PA)
Met-Pro Corp. (Harleysville, PA)
N.R.G. Co. (Ardmore, PA)
Parkson Corp. (Ft. Lauderdale, FL)
Passavant Corp. (Birmingham, AL)
Purestream, Inc. (Florence, KY)
Schreiber Corp. Inc. (Trussville, AL)

CONTACTS

See various references for design criteria (e.g., Fair et al., 1968, and WPCF, 1977).

Contact any sanitary engineer.

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-35

Advanced Wastewater Treatment

DESCRIPTION OF SYSTEMS

Multi-media filters - Suspended solids and any substances absorbed onto those solids are removed from solution.

Nitrification - ammonia is oxidized to nitrate in order to reduce the oxygen demanded by the wastewater.

Nitrogen removal - Nitrogen can be biologically converted (under anaerobic conditions) to nitrogen gas, stripped at high pH as ammonia gas or removed from solution by ion exchange.

Phosphorus removal - lime or alum can be added prior to final clarification to allow phosphorus to precipitate from solution as a metal-phosphate.

Activated carbon - powdered or granular carbon provides opportunity for adsorption of organics onto the carbon surface.

Purpose - to remove substances from wastewater that are not sufficiently removed in preceding treatment processes.

More intensive operation of the process is needed than for other preceding treatment processes.

COMPONENTS

Advanced treatment processes can be used separately or in combination. Chemicals may be needed as well as tanks, aerators, clarifiers, piping, meters, pumps and special equipment for certain processes (e.g., stripping tower for ammonia stripping).

EXAMPLES OF USAGE

Treatment facilities in the Great Lakes region include phosphorus removal. Nitrogen removal is included at some treatment facilities which discharge to coastal waters and other environmentally-sensitive surface waters.

MANUFACTURER

Filters

Clow Corp., Waste Treatment Div. (Florence, KY)
Davco Div., Davis Water and Waste Ind., Inc.
(Thomasville, GA)

Nutrient Removal (patented processors)

Dorr-Oliver (Stamford, CT)
Schramm, Inc. (West Chester, PA)
Air Products and Chemicals, Inc. (Allentown, PA)

Activated Carbon

Calgon Corp. (Pittsburgh, PA)
Westvaco Corp. (Covington, VA)
ICI Americas, Inc. (Wilmington, DE)

CONTACTS

Sanitary engineers and regulatory officials experienced with advanced wastewater treatment processes.

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-36

Sludge Treatment

DESCRIPTION OF SYSTEMS

Sludge Stabilization - Processes which chemically or biologically reduce microbial activity and odor production often while improving the ability of sludge to be dewatered. Examples of sludge stabilization processes for small facilities are lagoons, aerobic digestors, and use of lime or chlorine.

Sludge Drying - Processes which reduce the water content and volume of sludge to be disposed. Drying can occur due to solid-liquid separation, liquid evaporation and liquid filtration. Examples of sludge drying processes for small facilities are lagoons and drying beds (with or without covers).

More sophisticated processes which require more operation and maintenance are in wide use at many larger, municipal wastewater treatment plants.

MANUFACTURER

Aerobic digestion equipment

Dean Products, Inc. (Brooklyn, NY)
Walker Process Corp. (Aurora, IL)
Welles Products Corp. (Roscoe, IL)

COMPONENTS

Various types of unit structures and pumps are utilized depending upon the process(es) to be utilized. Mixers and/or aeration equipment could also be utilized.

Head can be added to enhance stabilization or drying. Chemicals or forced air could be added to enhance drying.

CONTACTS

Any sanitary engineer in the government or private sector.

EXAMPLES OF USAGE

Any municipal wastewater treatment plant.

MOUNTAIN COMMUNITIES
WASTEWATER MANAGEMENT
ASSESSMENT

ALTERNATIVES
DEVELOPMENT REPORT

FACT SHEET
ENGINEERING TECHNIQUES

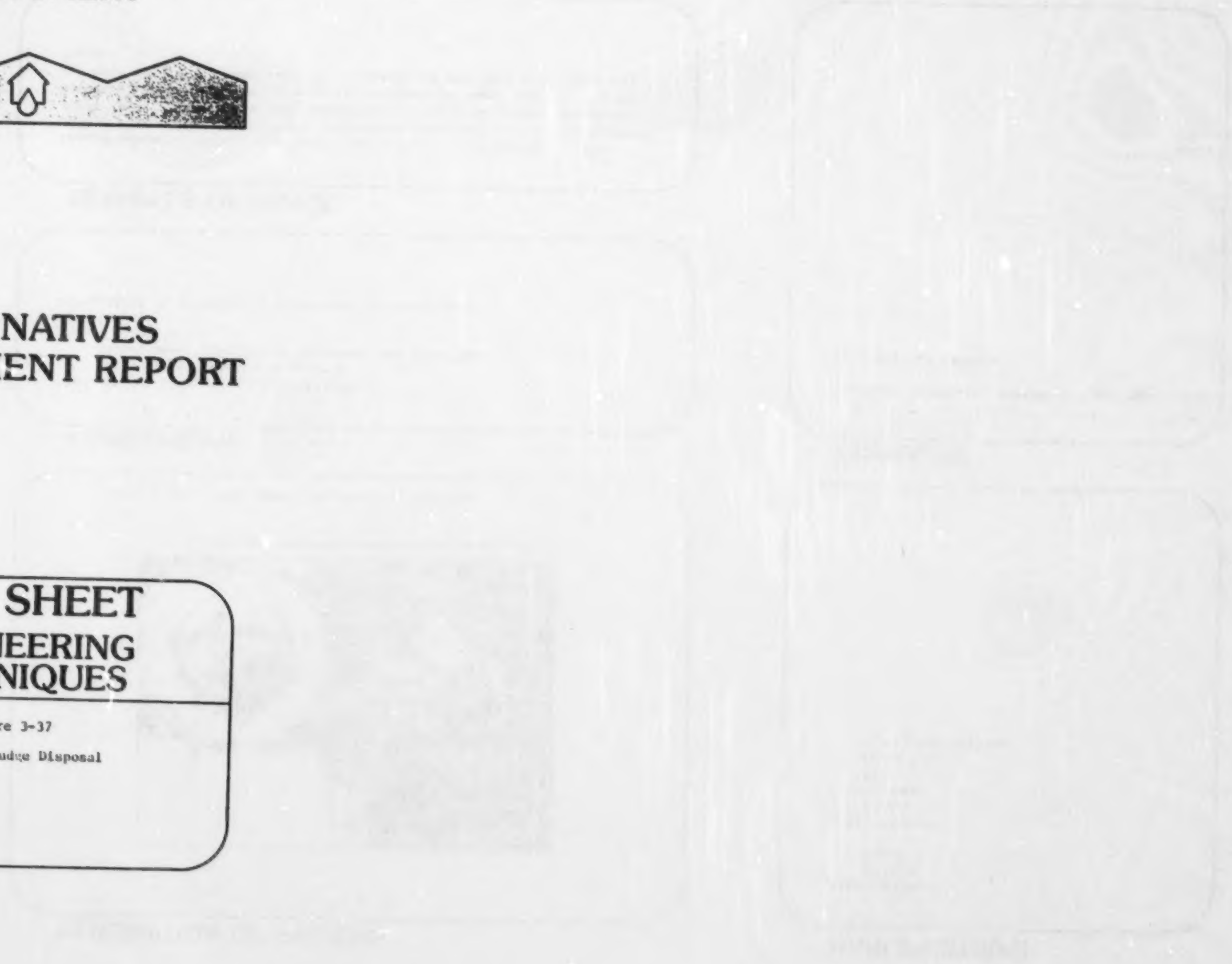
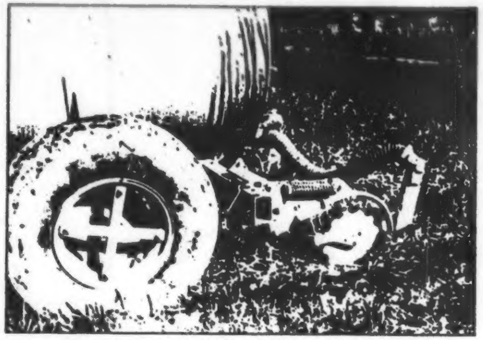


Figure 3-37

Septage or Sludge Disposal

DESCRIPTION OF SYSTEMS



Injector attachment mounted behind wheel allows slurry placement between crop rows.

Courtesy of: Penn State Ag. Extension Service

COMPONENTS

Land application/agricultural utilization
    Surface, topdressing of grasses
    Subsurface, injection on grassland and row crops
Trench disposal
Landfilling
Cotreatment at coventional wastewater treatment plant

EXAMPLES OF USAGE

Liquid manure spreaders with subsurface injectors are capable of disposing sludge from septic tanks and aerobic treatment units, onto agricultural lands. Septage has been successfully spread on grasses and plant residues. Surface spreading normally requires incorporation by discing for odor control. Sludge can also be composted and used on agricultural lands.

MANUFACTURER

Large (volume)
    AG Chem
    Big A

Small (volume)
    Martin
    Calumet
    Avco
    Deere & Co.
    Sperry-New Holland

CONTACTS

Municipal wastewater Treatment Plant Operations

Local septage haulers

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

138<

FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-39

Waste Flow Reduction
Water Conservation

DESCRIPTION OF SYSTEMS

Water Conservation

Water-Saving Devices and Fixtures
- Water carriage toilet inserts
    - Doms
    - Bottles
- Bathing devices
    - Reduced flow showerheads and inserts
    - On/Off showerhead valves
- Water Saving Toilets
- Non-water carriage toilets
    - Composting
    - Incineration
- Water meters

COMPONENTS

Aerators
Flow restrictors and line inserts
Toilet tank retrofit units (dual flush valves, dams, repair kits)
Repair kits for leaky fixtures
Water saving appliances
Level adjusters
Water Meters

EXAMPLES GE

Implementing water conservation procedures and installing waterflow reduction devices can result in significant reduction in water useage. Reduction in hydraulic loadings to soil absorption systems has enhanced system performance, corrected malfunctions and extended the periods of use.

MANUFACTURER

Nearly 70 principal manufacturers of fixtures and other water saving devices throughout the U.S.

CONTACTS

Local plumbing dealers

MOUNTAIN COMMUNITIES WASTEWATER MANAGEMENT ASSESSMENT

ALTERNATIVES DEVELOPMENT REPORT

140<

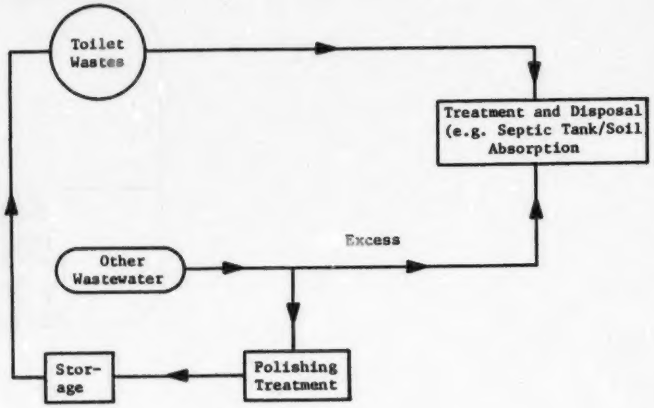
FACT SHEET

ENGINEERING TECHNIQUES

Figure 3-40

Waste Flow Reduction
Wastewater Recycle/Reuse

DESCRIPTION OF SYSTEMS


Toilet Wastes
Treatment and Disposal (e.g. Septic Tank/Soil Absorption
Other Wastewater
Excess
Polishing Treatment
Stor-age

COMPONENTS

Separate water supply and drain liners
Filters
Chemicals
Storage tanks
Seperate disposal system for resultant toilet waste and all gray water wastes

EXAMPLES OF USAGE

Wastewater recycle and reuse systems generally collect and treat graywater for future use in water-carriage toilets and possibly turf irrigation. Only sanitary and excess graywater enters the septic tank - soil absorption system.

MANUFACTURER

Components making up the system available from local plumbing supply and hardware stores.

CONTACTS

H

Center for Improving Mountain Living, Western Carolina University, Cullowhee, NC

CHAPTER 3 BIBLIOGRAPHY

BIBLIOGRAPHY

CHAPTER 3

American Society of Agricultural Engineers (ASAE). 1978. *Home Sewage Treatment. Proceedings of the Second National Home Sewage Treatment Symposium* held December 12-13, 1977. Published by ASAF. St. Joseph, MI. ASAE Publication 5-77.

American Society of Agricultural Engineers (ASAE). 1982. *On-Site Sewage Treatment. Proceeding of the Third National Symposium on Individual and Small Community Sewage Treatment* held December 14-15, 1-82. Published by ASAE. St. Joseph, MI. ASAE Publication 1-82

Berkowitz, S.J. 1981. *On-Site Wastewater Treatment Problems and Alternatives for Western North Carolina*. Center for Improving Mountain Living. Western Carolina University. Cullowhee, NC. Published by the Water Resources Research Institute of the University of North Carolina, Raleigh, NC. Report No. 163.

Boyle, W.C. and R.J. Otis. 1979. *On-Site Treatment.* University of Wisconsin. Madison, WI.

Fair, G.M., J.C. Geyer and D.A. Okun. 1968. *Water and Wastewater Engineering*. Volume 2. Water Purification and Wastewater Treatment and Disposal. John Wiley & Sons, Inc.

Hyland, P. *On-Site Disposal in Rural Kentucky*. Legislative Research Commission Research Report No. 155. Frankfort, KY.

Kentucky Cabinet for Human Resources. 1982. *Kentucky On-Site Sewage Treatment Systems*. Technical Manual. Department for Health Services. Frankfort, KY.

Laak, R. 1980. *Wastewater Engineering Design for Unsewered Areas*. Ann Arbor Science Publishers, Inc. Ann Arbor, MI.

Mancl, K.M. 1983. *Septic Tank Pumping*. The Pennsylvania State University. College of Agriculture, Cooperative Extension Service. State College, PA. Publication SW-40.

McClelland, N.E. 1976 through 1980. *Proceedings, Individual On-Site Wastewater Systems*. National Sanitation Foundation, Ann Arbor Science. Ann Arbor, MI.

Municipal Index (Published annually). Morgan-Grampian Publishing Co. Pittsfield, MA.

Nicholas, G.D. and Foree, E.G. 1981. *Evaluation of Boyd County, Kentucky Sanitation District No. 3 Home Wastewater Treatment Systems*. Applachian Regional Commission and Kentucky Department for Community and Regional Development. Published by Commonwealth Technology Inc. Lexington, KY.

Otis, R.J., Boyle, W.C. et al. 1977. On-Site Disposal of Small Wastewater Flows. University of Wisconsin. Madison, WI.

Pennsylvania Department of Environmental Resources (DER). 1983 (plus up-dates). Technical Manual for Sewage Enforcement Officers. Prepared by the Local Government Research Corp. State College, PA.

Public Works Journal Corporation. 1984 Public Works Manual. Ridgewood, NJ.

Salvato, J.A. 1982. Environmental Engineering and Sanitation. Third Edition. A Wiley-Interscience Publication. John Wiley and Sons, Inc.

Schutz, F.R. 1983. Madison County Clean Waters Project, Step I Sewage Facilities Planning Report. F.R. Schutz Consulting Engineers. Asheville, NC.

Triangle J Council of Governments. 1980. Final Report Individual Wastewater Project. 1978-79. Triangle J Council of Governments. Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA). 1977. Alternatives for Small Wastewater Treatment Systems. 1. On-Site Disposal/Septage Treatment and Disposal and 2. Pressure Sewers/Vacuum Sewers. EPA Technology Transfer Seminar Publication (EPA-625/4-77-011).

U.S. Environmental Protection Agency. 1977. Process Design Manual: Wastewater Treatment Facilities for Sewered Small Communities. Environmental Research Information Center. Cincinnati, OH. (EPA-625/1-77-009).

U.S. Environmental Protection Agency. 1979. Design Seminar Handout; Small Wastewater Treatment Facilities. EPA Technology Transfer. Environmental Research Information Center. Cincinnati, OH.

U.S. Environmental Protection Agency. 1980a. Design Manual: On-Site Wastewater Treatment and Disposal Systems. Office of Water Program Operations (Washington, DC) and Office of Research and Development. Municipal Environmental Research Laboratory. Cincinnati, OH. EPA 625/1-80-012.

U.S. Environmental Protection Agency. 1980b. Evaluation of Sludge Management Systems: Evaluation Checklist and Supporting Commentary. Office of Water Program Operations. Washington, D.C. Publication MCD-61 (EPA 430/9-80-001).

U.S. Environmental Protection Agency. 1980c. Innovative and Alternative Technology Assessment Manual. Office of Water Program Operations and Office of Research and Development. Washington, D.C. Publication MCD-53 (EPA 430/9-78-009).

U.S. Environmental Protection Agency. 1980d. Planning Wastewater Management Facilities for Small Communities. Municipal Environmental Research Laboratory. Cincinnati, OH. (EPA-600/8-80-030).

U.S. Environmental Protection Agency. 1981. Generic Facilities Plan for a Small Community: Stabilization Pond and Oxidation Ditch. Office of Water Program Operations. Washington, D.C. Publication FRD-18 (EPA-430/9-81-007).

U.S. Environmental Protection Agency. 1982a. Construction Grants '82. Office of Water Program Operations. Washington, D.C.

U.S. Environmental Protection Agency. 1982b. Draft Environmental Impact Statement: Blount County, Tennessee Wastewater Facilities. EPA 904/9-82-103. EPA-Region IV, Atlanta, GA.

U.S. Environmental Protection Agency. 1983. Rural Lakes Project Handbook, Region V. Water Division. Chicago, IL.

Water Pollution Control Federation and American Society of Civil Engineers. 1977. Wastewater Treatment Plant Design: A Manual of Practices. Prepared by a joint committee.

VOLUME II APPENDICES

APPENDIX II-A SITE SOIL SURVEY PROCEDURES

APPENDIX II-A

SITE SOIL SURVEY PROCEDURES[1]

Observation and evaluation of soil characteristics can best be determined from a pit dug by a backhoe or other excavating equipment. However, an experienced soil tester can do a satisfactory job by using a hand auger or probe. Both methods are suggested. Hand tools can be used to determine soil variability over the area and pits used to describe the various soil types found.

Soil pits should be prepared at the perimeter of the expected soil absorption area. Pits prepared within the absorption area often settle after the system has been installed and may disrupt the distribution network. If hand augers are used, the holes may be made within the absorption area. Sufficient borings or pits should be made to adequately describe the soils in the area, and should be deep enough to assure that a sufficient depth of unsaturated soil exists below the proposed bottom elevation of the absorption area. Variable soil conditions may require many pits.

Since in some cases subtle differences in color need to be recognized, it is often advantageous to prepare the soil pit so the sun will be shining on the face during the observation period. Natural light will give true color interpretations. Artificial lighting should not be used.

1. Soil Drainage

Soil drainage refers to the freedom from saturation of the soil pores. It relates directly to the balance of air and water in the internal pores of the soil. You can obtain direct evidence of drainage conditons in some cases by observing free water on the surface of the soil, in shallow wells or test probes, or by the presence of springs or seepy spots. The water table can be best observed in test pits dug in early spring and allowed to stay open and fill with water as the water table approaches equilibrium.

You can infer the soil drainage conditions to an extent by type of vegetation and plant root penetration. Soil drainage characteristics can also be inferred by soil colors. Bright, uniform brown, red, and yellow colors are associated with good drainage. Grey, pale yellow, blue, and green colors are associated with poor drainage and lack of aeration. Soil mottling is a variegated color pattern in the soil and is associated with a fluctuating water table. Black or very dark grey surface soil is associated with saturation for long periods of time. Metallic black coatings are usually concentrations of manganese formed as a result of restricted drainage.

The following drainage classes are of importance to the Sewage Enforcement Officer:

a. Well Drained - free of mottling to 40 inches; usually suitable for elevated sand mounds or in-ground systems if sufficient soil depth exists.

b. Moderately-well Drained - Mottled in lower B and/or upper C Horizon beginning at 20 inches to 40 inches; usually suitable for elevated sand mounds.

c. Somewhat Poorly Drained - mottled in upper B Horizon or lower A Horizon - beginning 10 inches to 20 inches from the surface; unsuitable.

d. Poorly Drained - grey or light grey surface soil. Mottled or gleyed soil begins less than 10 inches from the surface; unsuitable.

e. Very Poorly Drained - black or very dark grey surface soil mottling or gleying begins at or very near the surface; unsuitable.

2. Soil Permeability

Soil permeability is the rate of air or water movement through the soil. Factors that affect permeability are as follows:

a. Texture

Texture is the "feel" of the soil. The coarseness or fineness of the combination of mineral particles that together make up the soil. Most soils are made up of a mixture of particles that fall in three general classes: sand, silt, and clay. Sand is the coarsest material with a range in size from two millimeters to .05 millimeters. Silt is smaller yet, from .05 millimeters to .002 millimeters, often called two microns. Clay particles are all smaller than .002 millimeters.

The soil may also contain coarse rock fragments of one-quarter inch or larger. These fragments come in a range of sizes and shapes. For example, channery soils have significant quantities of flat rock fragments up to an inch thick and two to six inches in length and width. Flaggy fragments are somewhat larger than channery. These are less permeable than the soil around them. Because coarse fragments usually afford no renovation, it is important to know what proportions of the soil they occupy. The measurement must be made by volume, not weight, because they are heavier than the surrounding soil.

When considering waste disposal, a good blend of sand, silt, and clay is most desirable. One hundred percent sand has no chemical renovating power. One hundred percent silt has poor stability and little renovating capacity. Clay is the most important class of soil particles for renovating waste. However, excessively clayey soil has poor permeability. The presence of clay can be determined by the plasticity of the soil when wet, as well as by texture. The clay is sticky and helps bind the other soil particles together into aggregates.

b. Structure

The important factors in soil structure are the size, shape, and stability of the aggregate soil particles called "peds." The simpliest ped is a loose cluster of soil particles held together by clay and colloidal organic matter. This is called a granule and is common in surface soils. These granules are rounded, do not pack tightly and, therefore, are permeable.

In subsoils with a moderate to high proportion of clay, blocky structure is often found. Such structure results largely from the alternate swelling and cracking associated with alternate wetting and drying over long periods of time. These blocks under certain conditions have angular edges and corners, and the soil is called blocky. They do not fit together tightly even when wet; therefore, permeability is greater than angular blocky.

In the granular, blocky, and subangular blocky structures, the length, width, and height of the peds are roughly the same. If the vertical dimension, thickness is less than one-third as great as the horizontal dimension, length, the structure is described as platy. Platy soils have restricted permeability. A fragipan very often has platy structure and may be so low in permeability that it holds water on top of it, causing a perched water table.

If the long dimension of the structural unit is the vertical dimension and it is three times as great as the horizontal dimension, the structure is described as prismatic. The permeability of prismatic soil is generally similar to that of blocky soil.

Stability of soil structure is classed as weak, moderate, or strong. Weak structure is poorly formed and readily crumbles. Strong structure is conspicuous and durable, resisting crumbling. Moderate is an intermediate class.

The effect of detergents is to decrease the adherence between soil particles and, hence, decrease permeability and stability of peds. This dispersion of the soil particles can render a soil structureless.

Depth

Depth is an important characteristic because there must be sufficient depth of soil to allow the storage of the effluent while the chemical and biological actions are taking place and to provide adequate filtration. Adequate soil must be available also to provide sufficient depth for construction of the disposal system.

4. Consistence

Consistence is an easily-observed soil characteristic, but it is one that can change from day to day. Each soil has three sets of consistence characteristics - one for when it is wet, one for moist, and one for dry conditions. These can affect the actions of roots and animals in the soil and may hamper or limit mechanical operations of installing a sewage disposal system. It is also an important consideration of interpreting permeability.

5. Stoniness and Rockiness

Stoniness and rockiness indicate presence of stony or rocky conditions. Stoniness has already been discussed as one category of coarse fragments. Stones are unattached to bedrock. Rockiness is the presence of ledges or outcrops of bedrock reaching the surface. These conditions may present serious obstacles to mechanical operations, reduce extent of renovation, or facilitate movement of sewage effluent to ground water through fractures in the rock.

6. Flooding

Flooding refers to the overflow of an area by a stream or river, or by runoff in a drainage way or depression. Any overflow onto an installed subsurface disposal system greatly increases the chances of failure of that system either through destruction of the system by erosion or through interruption of the renovative process and clogging of the system. Such conditions also increase the probability of pollution.

E. Interpreting Soil Suitability for Subsurface Disposal of Septic Tank Effluent

1. **Suitable** - deep, well-drained, permeable soil with good filtration.

2. **Suitable but with Hazard of Ground Water Pollution** - deep, well-drained, permeable soil over gravel or limestone with fissures.

3. **Marginal** - moderately-deep or moderately-sloping soils.

4. **Unsuitable** - steep, shallow, not well-drained or subject to flooding.

F. Limiting Zone

Any horizon or condition in the soil profile or underlying strata which will interfere in any way with the renovation of sewage effluent before entering the ground water table is called a limiting zone. Limiting zones can consist of the presence of a water table condition sufficiently close to the surface that sewage effluent could be introduced to the ground water before being renovated by passage through suitable soils. Soil mottling is the most common indicator of a water table condition because it is evidence that the soils have been saturated sufficiently long enough to cause a chemical or physical change. Water tables can be either seasonal, regional, or perched (natural surface drainage restricted or held back by a soil structure).

The presence of a rock formation, other stratum, or even a soil condition which is so tight and impermeable that it effectively limits the downward passage of effluent is considered a form of limiting zone.

Rock with open joints, fractures or solution channels, or masses of loose rock fragments, including gravel, are all conditions which permit the downward passage of sewage effluent without proper renovation. The presence of these conditions indicates a lack of soil material through which the sewage effluent may filter and be renovated. A limiting zone exists whenever sewage effluent may pass freely through a portion of the soil horizon without renovation.

G. Procedure for Examining a Soil Profile

A Sewage Enforcement Officer should gather as much information as is possible regarding a site of a proposed on-lot system before evaluating a soil probe.

1. Before visiting the site, the Sewage Enforcement Officer may gather information regarding soil suitability and site limitations from any or all of the following:

   a. Local land owners, farmers, or municipal officials.

   b. Well drillers.

   c. County agents of U.S.D.A.

   d. The local sanitarian.

   e. The local Soil Conservation Service office.

   f. U.S.G.S. maps of the area.

   g. Soils survey for the county, if available.

2. If any of the information obtained before visiting the site would indicate the possibility of a floodplain, consult the local municipality's Federal Flood Insurance mapping, if available, or the S.C.S. mapping for identification of floodplains or flood prone soils.

3. On the initial visit to the site, check for obvious, unsuitable characteristics such as standing water, rock outcrops, slopes, or other conditions which would render the site unsuitable. Estimate the total amount of land available for use as an absorption area and make a rough determination of the slope.

4. It is recommended that all interested parties be present at the time of the soil evaluation, so that all can see the same conditions and obvious deficiencies can be explained immediately. If at all possible, it is recommended that the Sewage Enforcement Officer be present on the site as the soil probe is being excavated.

5. If road cuts, railroad embankments, or other exposed slopes are present, try to get a broad view of the landscape, soil, and geology of the area surrounding the site. Select potential sites for absorption areas on the lot and designate the probe locations. Check and record the slope over the potential sites.

6. Have soil probes excavated if no obvious, unsuitable characteristics are observed and if the slope is within the limits prescribed by the regulations. Examine the soil as it is removed for the presence of mottling, structure, bedrock, or other indicators of unsuitability. Before entering the probe to perform the examination of the soil profile, make sure that the probe is safe to enter. Check to be sure that the probe is constructed properly with a step-type configuration to allow safe entry and exit. The probe should have no side-wall slumps or show the potential for a cave-in. Be sure that no heavy piece of equipment or large objects, such as rocks or boulders, is resting on the surface immediately adjacent to the probe sidewalls. Once in the probe, check and make sure that no type of soil or rock debris will topple into the probe. If present when the probe is dug, have the operator align the excavation so that the best use can be made of the available sunlight.

7. Check the sidewalls of the probe to determine which wall will be described. Chose the soil face which will best represent the soil condition present. Using a pick-type tool

such as a knife, sharp hammer, or screwdriver, probe the sidewall from the top to bottom to reveal a fresh surface at least 10 inches wide. Make a general description of the probe, including such things as slope of the area, depth of the probe, depth to bedrock, depth to drainage mottling, depth to pan, depth to ground water, depth to seeps, and depth of the root zone. By repeated jabbing of the sidewall of the probe, the evaluator can identify changes in soil density and, thereby, identify different horizons. Heavy structures or pan-like limiting zones can be identified by their resistance to penetration.

8. Using the prepared section of the probe, identify horizons; measure the depth to the beginning and end of the horizons, and mark the lower boundaries with nails or other identifying objects.

9. Work from the lowest horizons toward the top of the probe to avoid disrupting the undescribed horizons as the lower soil is examined.

10. Describe the characteristics of each horizon using color, texture, consistency, structure, presence of roots or animal life; coarse fragments, bedrocks, mottling; examine the coarse fragments and bedrock and identify the type if possible.

11. Avoid making verbal decisions regarding suitability of the probe for a certain type of system. This should be reserved until the results of the percolation test and other factors can all be analyzed together. If the soil is unsuitable for the installation of an on-lot system, the permittee or persons available should be advised and notified that a percolation test may not be performed. The findings of a soils evaluation should be recorded. As a part of the soils description, the evaluator should designate the type of limiting zone present and the depth from the mineral soil surface observed.

---

[1] This description is mostly taken directly from the, Technical Manual for Sewage Enforcement Offices, Pennsylvania Department of Environmental Resources, 1983.

APPENDIX II-B STATE HEALTH DEPARTMENT CONTACTS

APPENDIX II-B

STATE HEALTH DEPARTMENT CONTACTS

Mr. Mike Cash
Director
Bureau of Sanitation
State Office Building
Room 316
Montgomery, AL 36130
(205)261-5007

Mr. Wilton Garrett
Environmental Protection Manager
Georgia Department of Human Resources
47 Trinity Avenue
Atlanta, GA 30334
(404)656-7045

Mr. Don Dixon
Section Supervisor
Food and Sanitation Branch
Department for Health Services
DHS Building
2nd Floor West
275 E. Main Street
Frankfort, KY 40621
(502)564-4856

Mr. Steve Steinbeck
Supervisor, On-Site Sewage Disposal Unit
P.O. Box 2091
Raleigh, NC 27602-2091
(919)733-2261

Mr. Phillip Cooper
Director, Division of General Sanitation
South Carolina Department of Health
  and Environmental Control
2600 Bull Street
Columbia, SC 29201
(803)758-3908

Mr. L. Eugene Barnett
Division of Environmental Sanitation
Tennessee Department of Public Health
R.S. Gass State Office Building
Ben Allen Road
Nashville, TN 37216
(615)741-7206

★U.S. GOVERNMENT PRINTING OFFICE:1984 -545 -063/